PROGRAMMABLE SCIENTIFIC CALCULATOR
CALCULADORA CIENTIFICA PROGRAMABLE

CASIO FX-603P

INSTRUCTION MANUAL
MANUAL DE INSTRUCCIONES

英西

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Foreword

Thank you for purchasing the CASIO FX-603P.
This unit is an advanced hand held programmable computer that features a two-tier display and alphabetic display capabilities. Scientific functions are provided in addition to a programming function for performing repeat or complex calculations.
6,144 steps and 110 memories make it possible to perform even long, complex programs. The function calculation speed is almost four times* that of the Casio FX-602P.
The optional FA-6 Interface Unit allows connection with a cassette tape recorder. This permits data transfer of programs and the contents of memory between the FX-603P and a cassette tape recorder. Connection with an FP-40 or FP-100 printer provides print capability for displays, programs and memory contents. An RS-232C communications interface is also made available for data communications.

**Based upon the processing time required by the LSI for internal calculations. It should be noted, however, that the amount of time required to produce data on the LCD is the same. This means that the increase in speed will only be evident with more complex calculations and virtually unnoticeable with simpler operations.*

- Programs created on the FX-602P, except music programs, can be run on the FX-603P without modification, although some displays have been changed.

This manual consists of three sections:
1. Manual calculations
2. Program calculations
3. Using Peripheral Equipment

Each section explains the basic operation of this unit and should be read in order to master both types of calculations.

Important — Always back up data!

This product features electronic memory that is capable of easily storing large volumes of data. But you should also remember that your data is safely stored only as long as power is being supplied to the memory. This means that if you let battery power become too low, if you make a mistake while replacing batteries, or if power supply is cut off, the data stored in the memory will be irreparably damaged or lost entirely.
Data can also be damaged by strong electrostatic charge or impact, or by environmental extremes. Once data is damaged or lost, it cannot be recovered, so we strongly recommend that you back up all important data on cassette tape, via the optional Casio FA-6 interface unit.

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Before Using Your Computer ...

This unit was made possible by Casio's advanced electronics technology, intensive quality control, and a rigorous inspection process. Please observe the following points to prolong service life.

Handling Precautions

- Be sure to keep the connector covered when it is not in use to protect it against dirt and dust. Avoid touching the connector at all times.
- When the "Low Battery!" message appears on the display as you are using the unit, replace the main power supply batteries (A) as soon as possible.
- Be sure that the power switch is set to OFF when replacing batteries.
- If the computer is exposed to a strong static electrical charge, its memory contents may be damaged or the keys may stop working. In such a case, press the RESET button following the P button to clear the memory and restore normal key operation.
- Be sure that the power of the computer is switched OFF whenever making any connection to another device.
- Never switch the power of the computer OFF while it is executing a program or performing a calculation.
- Note that strong vibration or impact during program execution can lead to termination of the execution or damage of the computer's memory contents.
- Using the computer next to a television or radio can cause interference with reception.
- Should servicing become necessary, contact your nearest Casio dealer.
- This unit is manufactured of precision electronic components, and should never be disassembled. Do not drop it or otherwise subject it to sudden impact, or sudden temperature change. Be especially careful to avoid storing the unit or leaving it in areas exposed to high temperature, humidity or large amounts of dust. When exposed to low temperatures, the unit will require more time to display results and may even fail to operate. The display will return to normal once normal temperature is attained.
- Do not use any adaptors other than the options specified for this unit.
- Batteries should be replaced every two years even if the unit is not used for extended periods. Never leave dead batteries in the battery compartment. They can leak and cause damage to the unit.
- Avoid using volatile liquids such as thinner or benzine to clean the unit. Wipe the unit with a soft, dry cloth or a cloth that has been dipped in a neutral detergent solution and wrung out.
- Before assuming malfunction of the unit, be sure to carefully reread this manual and ensure that the problem is not due to insufficient battery power, programming or operational errors.

Power and Battery Replacement

Power is supplied to this unit by two lithium batteries (CR2032). A third lithium battery (CR2032) is used as a memory protection power supply.

■Replacing the Main Power Supply Batteries

About the "Low Battery!" Message

When the "Low Battery!" message appears on the display as you are using the unit, replace the main power supply batteries (A) as soon as possible. To avoid loss of memory contents, the unit will automatically switch OFF if you continue operation without changing batteries. If the unit switches OFF, you will not be able to switch it back ON until you replace batteries. Normal operation will be possible after you replace the main power supply batteries (A).

*If, for some reason, all three batteries have been removed from the unit, reload the batteries in the battery compartment, switch the power ON, and press the P button and then press the ALL RESET button with a pointed object. All programs and data stored in the unit will be erased.

Cautions:

Incorrectly using batteries can cause them to burst or leak, possibly damaging the interior of the unit. Note the following precautions:

- Be sure that the positive ⊕ and negative ⊖ poles of each battery are facing in the proper direction.
- Never mix batteries of different types.
- Never mix old batteries and new ones.
- Never leave dead batteries in the battery compartment.
- Remove batteries if you do not plan to use the unit for long periods.

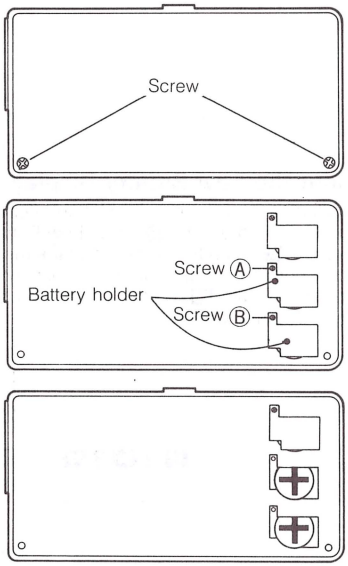
•Replace batteries at least once every 2 years, no matter how much the unit is used during that period.
•Never try to recharge the batteries supplied with the unit.
•Do not expose batteries to direct heat, let them become shorted, or try to take them apart.

Keep batteries out of the reach of small children. If swallowed, consult with a physician immediately.

Main Power Supply Battery Precautions

•Never remove the main power supply batteries and the backup power supply battery from the unit at the same time.
•Be sure that the power switch of the unit is in the OFF position before starting the battery replacement procedure. Replacing batteries with the power switch in the ON position will cause programs and data to be erased.
•Never set the power switch of the unit to the ON position while the main power supply batteries are removed from the unit or while the battery holders are not securely installed. Doing so will cause data stored in memory to be erased.
•Replace both batteries, and never mix new batteries with old ones.
•Never remove all three batteries at the same time. If you do, all programs and data stored in the unit will be erased.

(1) Switch power OFF, use a screwdriver to remove the two screws holding the back cover of the unit in place, and remove the back cover.
(2) Remove screws Ⓐ and Ⓑ to release the battery holders, and then remove the battery holder.
(3) Remove both of the batteries from the unit. This can be done easily by turning the unit so the battery compartment is facing down, and then lightly tapping the unit.
(4) Wipe the surfaces of two new batteries with a soft, dry cloth and load them into the unit with their positive ⊕ sides facing up.
(5) Fasten the battery holders in place using screws Ⓐ and Ⓑ and replace the back cover.
Programs and data stored in the unit are protected by the backup power supply battery while you are changing the main power supply batteries.



*Do not replace the main power supply batteries, and the backup power supply battery at the same time.

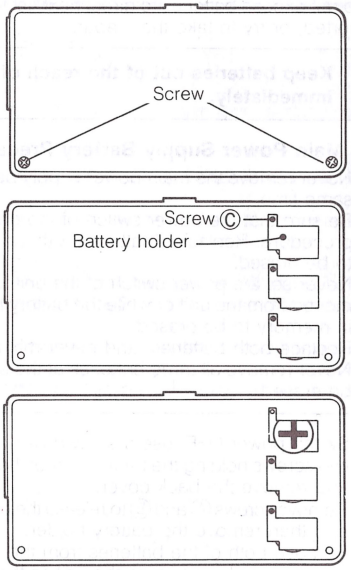
■Replacing the Backup Power Supply Battery

Backup Power Supply Battery Precautions

•Never remove the backup power supply battery and the main power supply batteries from the unit at the same time.
•Be sure that the power switch of the unit is in the OFF position before starting the battery replacement procedure.
•Replace the backup power supply battery at least once every two years, regardless of how much you use the unit during that period. Failure to do so can result in erasure of programs and data stored in memory. A sticker on the battery holder indicates when the first battery replacement should be performed.
•Before replacing the backup power supply battery, be sure to check the display of the unit first. If the message "Low battery!" is shown on the display, replace the main power supply batteries before replacing the backup power supply battery.

The service life of the backup power supply battery is two years. Replace this battery once every two years no matter how much you use the unit.

(1) Switch power OFF, use a screwdriver to remove the two screws holding the back cover of the unit in place, and remove the back cover.
(2) Remove screw Ⓒ to release the battery holder, and then remove the battery holder.
(3) Remove the old backup power supply battery from the unit. This can be done easily by turning the unit so the battery compartment is facing down, and then lightly tapping the unit.
(4) Wipe the surface of a new battery with a soft, dry cloth and load it into the unit with the positive ⊕ side facing up.
(5) Fasten the battery holder in place using screw Ⓒ , and replace the back cover.



■About the Low Battery Display

If you attempt to perform a calculation after the message "Low Battery!" appears on the display, the display will go blank by pressing AC. The "Low Battery!" display appears again whenever you switch the power ON. If you press AC while the screen is blank (as you do to resume power after activation of the Auto Power OFF function), nothing will appear on the display (not even the "Low Battery!" message). However, if you switch the power ON with AC ON after power has been switched OFF by the auto power OFF function, the "Low Battery!" display appears.

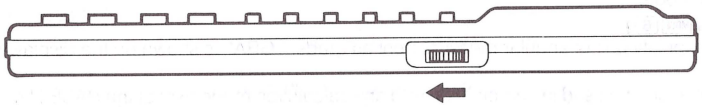
	Low Battery!
AC 2 × 3 =	6.
AC ON	0.
Power switch OFF→ON	Low Battery!

■Auto Power OFF

The power of the unit is automatically switched OFF approximately 6 minutes after the last key operation (except during program execution). If power is automatically switched OFF, you can restore power by switching power ON again, or by pressing AC ON to restore power. Programs and data are retained even if power is switched OFF by the Auto Power OFF function.

■Contrast Adjustment Dial

Display contrast can be adjusted using the contrast adjustment dial on the right side of the unit.



Rotate the dial in the direction indicated by the arrow to make the characters on the display darker. Rotate the dial in the opposite direction to make characters lighter. If the characters on the display are too light even if you set contrast to maximum darkness, it may indicate that battery power is too low. In this case the batteries should be replaced as soon as possible.

Operations

Programmable computers, unlike conventional calculators, have many keys with multiple functions. This section explains the basic operations of your programmable computer and should be read before you attempt operations.

1. Keys

Many of the keys have multiple functions.

[ABS / (-) / NEG / K] has four functions, including +/−, ABS, K and NEG. The function changes depending on the mode that the unit is currently in (see pages 7 and 8). Press this key directly to use the +/− function. Press [SHIFT] and then this key to use the ABS function. Press [ALPHA] and then this key for the K function input. The NEG function is valid only in the BASE-N mode, for negative binary, octal, decimal and hexadecimal functions (see page 8). The functions printed on the keys are color coded for easy recognition. Press [SHIFT] to perform functions marked in orange. Press [ALPHA] to perform functions marked in red. The BASE-N mode functions are marked in green.

Functions marked in yellow can be performed after you press [2ndF], such as the "VER" function for [PAUSE VER / HLT / G].

Note that "$\bar{x}$" and "Σx^2" for [$\bar{x}$ Σx^2 / 7 / Σ] are printed in blue brackets. Such functions are used for standard deviation calculations (SD calculations) (see page 34).

The following shows a summary of keys and their functions:

[SHIFT] key ..... Functions marked in orange
[2ndF] key ..... Functions marked in light green
[ALPHA] key ..... Functions marked in red
BASE-N mode ..... Functions marked in green
SD calculations ..... Functions bracketed in blue

2. Modes

To perform a calculation, you must first specify the type of calculation using the [MODE] and a numeric key. A sticker below the display of the computer shows a table of modes and the operation to perform to enter each mode.

■Operation Modes

There are a total of three operation modes.

1. RUN mode ([MODE] [1])
Use this mode for manual calculations and program execution. "RUN" is shown on the display while the unit is in this mode.

2. WRT mode ([MODE] [2])
Use this mode for program storage and editing. "WRT"is shown on the display while the unit is in this mode.

3. PCL mode ([MODE] [3])
Use this mode for deletion of stored programs. "PCL" is shown on the display while the unit is in this mode.

■Angle Specification Modes

4. DEG mode ([MODE] [4])
Use this mode to specify the unit of angular measurement as degrees. "DEG"is shown on the display while the unit is in this mode.

5. RAD mode (MODE 5)
Use this mode to specify the unit of angular measurement as radians. "RAD" is shown on the display while the unit is in this mode.

6. GRA mode (MODE 6)
Use this mode to specify unit of angular measurement as grads. "GRA" is shown on the display while the unit is in this mode.

*Modes 4 through 6 can be used in combination with any calculation mode except the BASE-N mode (MODE −). The unit is always in the DEG mode after you switch power ON.

■Calculation Modes

COMP mode (MODE +)
Use this mode for arithmetic calculation or function calculation. The unit of angular measurement is shown on the display, and the last unit specified remains in effect. Nothing appears to indicate the COMP mode in the BASE-N mode or any other mode.

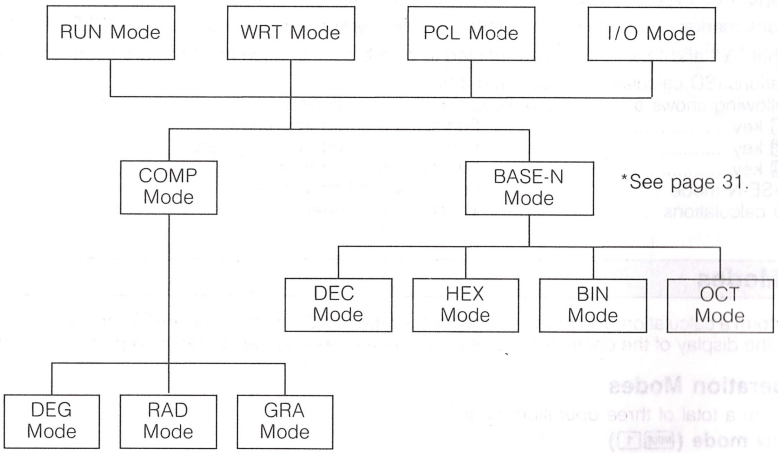
BASE-N mode (MODE −)
Use this mode for binary, octal, decimal, and hexadecimal calculations/conversions and logic calculations. "BASE-N" is shown on the display while the unit is in this mode.
*The COMP mode and the "BASE-N" mode cannot be used in combination. The unit is always in the COMP mode after you switch power ON.

■I/O Mode

I/O mode (MODE ×)
Use this mode to exchange data with a data recorder, printer or other peripheral equipment. "I/O" is shown on the display while the unit is in this mode.

MT Reverse Mode (MODE ÷)
Use this mode to invert the phase when loading data from a data recorder. "R" is shown on the display while the unit is in this mode.
*The phase can be confirmed in the I/O mode.

The mode hierarchy can be represented as follows:



*See page 31.

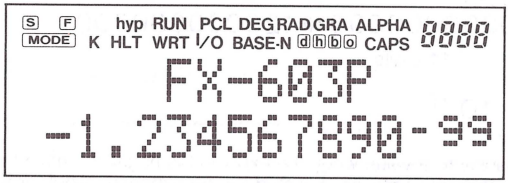
I/O: Abbreviation for input/output
COMP: Abbreviation for compute
DEC: Abbreviation for decimal number
HEX: Abbreviation for hexadecimal number
BIN: Abbreviation for binary number
OCT: Abbreviation for octal number

*Switch the power OFF and then ON again to set the modes to their initial status.

3. Displays

■Display Indicators

The computer's status can be confirmed from the indicators shown at the top of the display.



Indicators

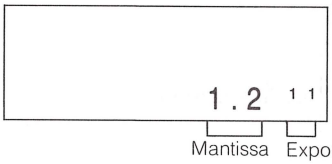
- S : SHIFT key pressed
- F : 2ndF key pressed
- hyp : hyp key pressed
- RUN : RUN mode entered
- PCL : PCL mode entered
- DEG : DEG mode entered
- RAD : RAD mode entered
- GRA : GRA mode entered
- ALPHA : Alphabetic character input mode
- MODE : MODE key pressed
- K : Constant calculation mode
- HLT : HLT mode
- WRT : WRT mode entered
- I/O : I/O mode entered
- BASE-N : BASE-N mode entered
- d : Decimal calculation in the BASE-N mode
- h : Hexadecimal calculation in the BASE-N mode
- b : Binary calculation in the BASE-N mode
- o : Octal calculation in the BASE-N mode
- CAPS : CAPS mode

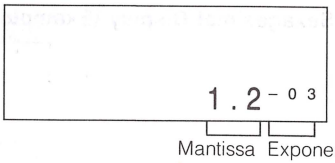
■Two-Tier Display

This unit is equipped with a 16-digit, two-tier display with alphabetic-numeric capabilities. Ten digits for mantissas and two digits for exponents are provided on the lower display for manual calculations. Both the upper and lower displays are utilized in the WRT mode for program display.

■Exponential Display

Results of calculations are normally displayed with a maximum of ten digits. However, exponential display is automatically performed for any number less than 0.01 (10^{-2}) or greater than 10 billion (10^{10}). The display appears as follows when the calculation range is exceeded:





➡ 1.2×10^{11} ➡ 120,000,000,000 (120 billion)

➡ 1.2×10^{-3} ➡ 0.0012

Exponential display conventions
To convert an exponential display to a value when the exponent is positive, move the decimal place of the value to the right, the number of decimal places indicated by the exponent. Add zeros as required.

Example

1.2
└ Delete
00000000000 ➡ 120000000000
11 digits

1.2×10^{11}

To convert an exponential display to a value when the exponent is negative, move the decimal place of the value to the left, the number of decimal places indicated by the exponent. Add zeros as required.

Example

1.2
└ Delete
0.000 ➡ 0.0012
3 digits

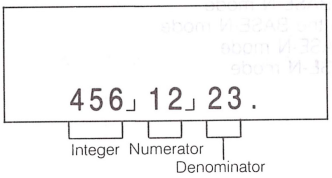
1.2×10^{-3}

See exponential input with the EXP key (page 15) and exponential display with the ENG key (page 16).

■Special Displays

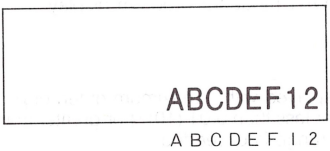
Calculations of fractions and hexadecimal calculations produce special display formats.

•Display of Fractions (Example)



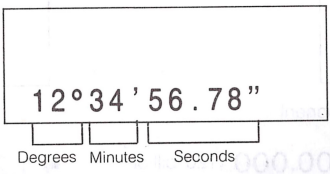
[Display of $456\frac{12}{23}$]

•Display of Hexadecimal Numbers (Example)



[Display of ABCDEF12 (= −1412567278)]

•Sexagesimal Display (Example)

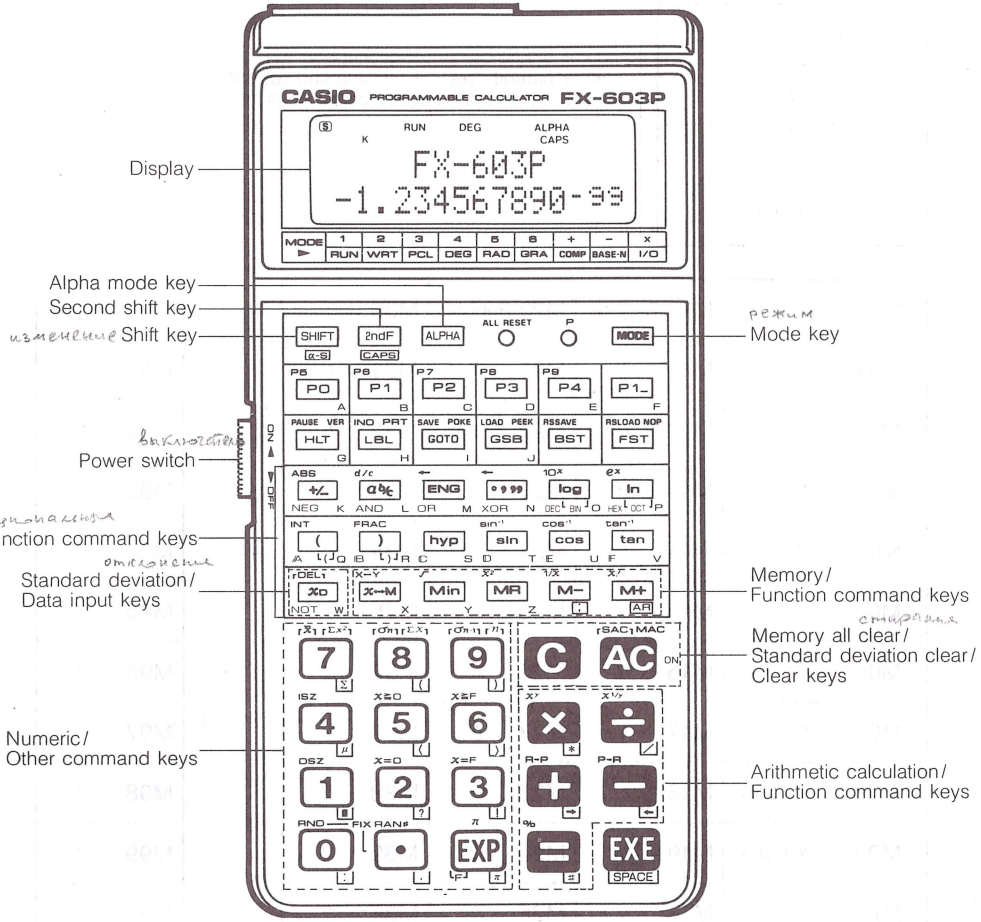


[Display of 12°34'56.78"]

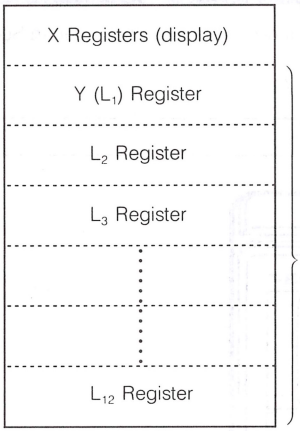
Section 1 Manual Calculations

Manual calculation functions are explained in this section. Programming functions are explained later, in Section 2.

Manual Calculation General Guide



■Internal Registers



- For arithmetic and function calculations
  (Alphabetic characters and symbols are valid for X registers.)
- For parentheses calculations and subtraction/division precedence calculations

M00 Register	M10 Register	M20 Register	M30 Register	M90 Register
M01 //	M11 //	M21 //	M31 //	M91 //
M02 //	M12 //	M22 //	M32 //	M92 //
M03 //	M13 //	M23 //	M33 //	M93 //
M04 //	M14 //	M24 //	M34 //	M94 //
M05 //	M15 //	M25 //	M35 //	M95 //
M06 //	M16 //	M26 //	M36 //	M96 //
M07 // (Σx^2)	M17 //	M27 //	M37 //	M97 //
M08 // (Σx)	M18 //	M28 //	M38 //	M98 //
M09 // (n)	M19 //	M29 //	M39 //	M99 //
MF //	M1F //	M2F //	M3F //	M9F //

- 110 independent memories (M00 to M99, MF, M1F to M9F) plus Σx^2, Σx, and n totalizers for standard deviation calculations (M07, M08, and M09 only)

*Independent memories are referred to as "Mn registers" in this manual.

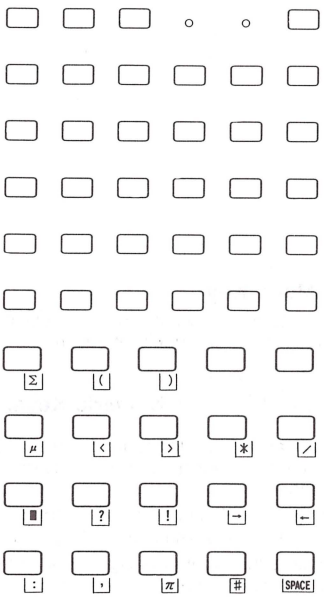
■Key Functions

Power Switch

Slide the power switch up to switch power ON. Data in memory and programs are retained even if power is switched OFF.

SHIFT α-S Shift/Alpha Shift Key

- Press to use function commands and functions marked on the key panel in orange. Press SHIFT and "S" appears on the display. Press SHIFT again and the "S" disappears from the display.
- Press this key in the Alpha mode to use the following key functions. ("S" appears on the display.)

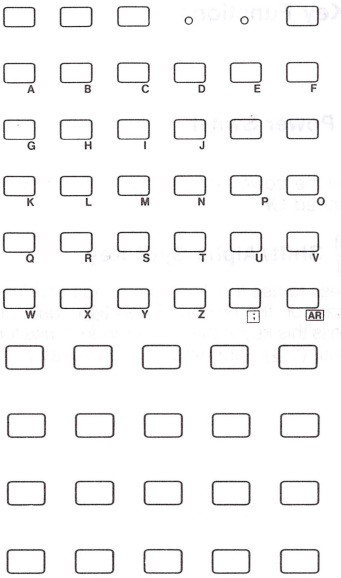


2ndF CAPS Second Shift/CAPS Key

- Press to use function commands and functions marked on the key panel in light green. Press 2ndF and "F" appears on the display. Press 2ndF again and the "F" disappears from the display.
- Press this key in the Alpha mode and "CAPS" appears on the display indicating that the alphabetic character mode has switched from lowercase to all caps.

[ALPHA] Alpha Mode (Character Input Status) Key

Press this key to enter the alpha (character input) mode ("ALPHA" indicator shown on the display). The alphabetic character, symbol, number and arithmetic command symbol on the bottom of each key marked in red can be displayed in the alpha mode. (Calculations cannot be displayed.) Press [ALPHA] in the alpha mode to exit the alpha mode.



[MODE] Mode Key

Press [MODE] and a numeric key from [1] to [6] or an arithmetic operation key ([+], [−], [×], [÷]) to set the unit's status and unit of angular measurement. See pages 7 and 8 for details about the modes.

[0] to [9], [·] Numeric Keys, Decimal Point Key

- Enter values from left to right. Press [·] to enter a decimal point.

*You cannot enter a number that is more than ten digits long. Any numeric key pressed after the tenth digit is ignored.

- [SHIFT] [RND] [ ] . . . Number of Significant Digits
  - 1 to 9, and 0 (0 = 10 significant digits)

Specifies the number of significant digits. For example, [SHIFT] [RND] [4] specifies four digits. If the value for the 5th digit is five or greater, the 4th digit is rounded up. If the value for the 5th digit is four or less, the value for the 4th digit is unchanged.

- [SHIFT] [RND] [FIX] [ ] . . . Number of Decimal Places
  - 1 to 9, and 0 (0 = no decimal values)

Specifies the number of decimal places. For example, [SHIFT] [RND] [FIX] [2] specifies two decimal places. If the value for the 3rd decimal place is five or greater, the 2nd decimal place is rounded up. If the value for the 3rd decimal place is four or less, the value for the 2nd decimal place is unchanged.

- [SHIFT] [RAN#] ..... Random Number Generation

Generates pseudo random numbers from 0.000 to 0.999.

- [SHIFT] [$\bar{x}$] ..... Mean ($\bar{x}$) Calculation
- [MR] [0] [Σx^2] ..... Sum of Squares (Σx^2) Calculation
- [SHIFT] [σn] ..... Standard Deviation (σn) Calculation
- [MR] [0] [Σx] ..... Sum of Data (Σx) Calculation
- [SHIFT] [$\sigma n-1$] ..... Standard Deviation (σn-1) Calculation
- [MR] [0] [n] ..... Number of Data Items (n) Calculation

Used for standard deviation calculations. See "Standard Deviation Calculations" for a more detailed explanation.

[R→P] [P→R] [x^y] [$x^{1/y}$] Arithmetic Operation Keys/ [%] [=] Equal Key

- Press keys in the same order as they appear in the formula to perform arithmetic operations. Press [=] to display the final result. Press an arithmetic operation key twice in succession to enter constant calculation, displaying the "K" indicator (see page 22).

- [SHIFT] [x^y] ..... Power Multiplication Command — Press to raise x to the y power.
- [SHIFT] [$\sqrt[y]{x}$] ..... Power Root Command — Press to raise x to the $1/y$ power.
- [SHIFT] [R→P] ..... Coordinate Conversion Command — Press to convert rectangular coordinates to polar coordinates.
- [SHIFT] [P→R] ..... Coordinate Conversion Command — Press to convert polar coordinates to rectangular coordinates.
- [SHIFT] [%] ..... Percent Command — Press to calculate percentages and ratios, premiums, discounts, and rate of change (increase/decrease ratios, etc.).

[SAC] [MAC]
[AC] [ON] All Clear/Standard Deviation All Clear/Memory All Clear Key

- Press to clear everything (all X registers, Y registers, registers for parentheses) except the M*n* registers (independent memory).
- Press to clear an error message display (see page 19).
- Press to restore power following activation of the Auto Power OFF function (see page 6).

[C] Clear Key

- Press [C] to clear the entry of values (including exponents and angles) or characters, the result of functions in mixed calculations, or the results of parentheses calculations. The calculation is retained; only the display is cleared.
  Press [C] when the message "( ) Error" (overflow of mixed calculation or parentheses calculation register) is displayed, to display the result that existed before the error.

π
[EXP]
[F] [π]
Exponent/Pi Key

- Press [EXP] after entering the mantissa and before entering the exponent.

Example: $25.56 \times 10^{34} \rightarrow 2.56$ [EXP] 34

*[EXP] can be used as the pi key following operation of any key other than a numeric key ([0] to [9], [•]).
*Exponents up to ±99 can be used. When a value longer than two digits is entered, the last two digits entered are used as the exponent.

- Press [EXP] to enter pi (π). Following entry of a value, press [SHIFT] followed by [EXP] to display π.
- Press a memory key ([•] to [M+]) and then press [EXP] to specify the M_F register.

Example: Add 25 to M_F register. → 25 [M+] [EXP] [F]
Display contents of M_{1F} register. → [MR] [1] [EXP] [F]

ABS
[+/−]
NEG K
Sign Change/Absolute Value/Negative Key

- Press to change the displayed value from positive to negative, or negative to positive. Press [EXP] and then this key to change the sign of an exponent.
- Following [SHIFT] ([SHIFT] [ABS]), this key returns the absolute value of the displayed value.
- Negative values can be handled in the BASE-N mode. Negative values are represented as two's complements ([NEG] indicator shown on the display).

d/c
[a b/c]
AND L
Fraction/AND Key

- Use this key to enter fractions and mixed numbers.

For example, press 23 [a b/c] 45 to enter $\frac{23}{45}$. Press 2 [a b/c] 3 [a b/c] 4 to enter $2\frac{3}{4}$.

- Following [SHIFT] ([SHIFT] [d/c]), this key returns the improper fraction of the displayed value.
- In the BASE-N mode, key ([AND]) functions as logical AND (logical product).

[ENG] Engineering/OR Key

OR M

- Pressing this key while a value is displayed switches to an exponential display. Then each press moves the decimal point of the value three places to the right, changing the exponent accordingly. Following [SHIFT], each press of this key moves the decimal place three places to the left and changes the exponents.

Example

12.3456	12.3456
(first) [ENG]	12.3456 ^{00}
(second) [ENG]	12345.6 $^{-03}$
(next) [ENG]	12345600. $^{-06}$
(next) [ENG]	12345600. $^{-06}$ (No change)

12.3456	12.3456
(first) [SHIFT] [ENG]	0.0123456 ^{03}
(second) [SHIFT] [ENG]	0.000012345 ^{06}
(next) [SHIFT] [ENG]	0.000000012 ^{09}
(next) [SHIFT] [ENG]	0.000000012 ^{09} (No change)
[ENG]	0.000012345 ^{06}
[ENG]	0.0123456 ^{03}

Shifting the decimal place produces the following results: 10^{3} = k (kilo); 10^{9} = G (giga); 10^{-3} = m (milli); 10^{-6} = μ (micro); 10^{-9} = n (nano); 10^{-12} = p (pico)

- In the BASE-N mode, this key ([OR]) functions as logical OR (logical sum).

[°'"] Degree-Minute-Second/Decimal-Sexagesimal Conversion/XOR Key

XOR N

- Press this key to enter sexagesimal values for degree-minute-seconds or hour-minute-seconds calculations.
  Example: 78°45'12" → 78 [°'"] 45 [°'"] 12 [°'"]
- Following [SHIFT] key, this key displays the decimal value equivalent for values entered using degree-minute-second or hour-minute-second format.
- In the BASE-N mode, this key ([XOR]) functions as XOR (exclusive logical sum).

[log] log/10^{x}/Decimal Specification/Binary Specification Key

10^{x} DEC BIN O

- Press to calculate the logarithm ($\log_{10}$) of the displayed value.
- Following [SHIFT] key, this key raises 10 to the power represented by the displayed value (antilogarithm of displayed value = inverse function of [log]).
- In the BASE-N mode, press this key ([DEC]) to enter the decimal calculation mode.
- In the BASE-N mode, press this key following [SHIFT] ([SHIFT] [BIN]) to enter the binary calculation mode.

[ln] ln/e^{x}/Hexadecimal Specification/Octal Specification Key

e^{x} HEX OCT P

- Press to calculate the natural logarithm (e = 2.7182818 ...) of the displayed value.
- Following [SHIFT] key, press this key to raise e to the power represented by the displayed value (inverse function of [ln]).
- In the BASE-N mode, press this key ([HEX]) to enter the hexadecimal calculation mode.
- In the BASE-N mode, press this key following [SHIFT] ([SHIFT] [OCT]) to enter the octal calculation mode.

[(] Open Parenthesis/Integer Key

INT A Q

- Press this key to enter an open parenthesis (12 levels, nesting up to 36 sets).
- Following [SHIFT], press this key to extract the integer portion of the displayed value.

[)] Close Parenthesis/Fraction Key

FRAC B R

- Press this key to enter a close parenthesis.
- Following [SHIFT], press this key to extract the decimal portion of the displayed value.

[hyp] Hyperbolic Key

- Press this key followed by [sin], [cos], or [tan] to calculate the corresponding hyperbolic function (sinh, cosh, tanh) of the displayed value.
- Following [SHIFT], press this key and then an inverse hyperbolic key to calculate the corresponding inverse hyperbolic function ($\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$) of the displayed value. This key operation can also be performed as [hyp] key, followed by [SHIFT] and then an inverse hyperbolic key.

[sin] [cos] [tan] Trigonometric Function/Inverse Trigonometric Function Key

- Press to calculate a trigonometric function (sin, cos, or tan) for the displayed value.
- Following [SHIFT], press this key to calculate an inverse trigonometric function ($\sin^{-1}$, $\cos^{-1}$, or $\tan^{-1}$) for the displayed value.

*Use the following keys to enter hexadecimal values A_H through F_H:

Value	Key	Value	Key	Value	Key
A_H	[(]	C_H	[hyp]	E_H	[cos]
B_H	[)]	D_H	[sin]	F_H	[tan]

[Xo] Standard Deviation Data Input/Delete/NOT Key

- Press to enter data for standard deviation calculations.
- Following [SHIFT], press this key to delete data that has been input for standard deviation calculations.
- In the BASE-N mode, this key functions as logical NOT (negation).

[X↔M] Register Conversion Key

- Press this key to switch the contents of the X register (displayed value) with those of the M*n* register (independent memory).

Example: Switch a displayed value with the contents of memory #05 (M05 register). → [X↔M] [0] [5]

- Following [SHIFT], pressing this key switches the contents of register Y (internal calculation results) with those of register X.

[Min] Memory In/Square Root Key

- Press this key (and a numeric key) to save the displayed value to the M*n* register. Any value currently stored in the register is replaced with the new value.
- Following [SHIFT], press this key to calculate the square root of the displayed value.

[MR] Memory Recall/Square (x^2) Key

- Press this key (and a numeric key) to display the value in the M*n* register, without changing memory contents.
- Following [SHIFT], press this key to calculate the square of the displayed value (x^2).

[M−] Memory Minus/Inverse Key

- Press this key (and a numeric key) to subtract the displayed value from the value in the M*n* register.
- Following [SHIFT], press this key to calculate the inverse of the displayed value ($1/x$).

[M+] Memory Plus/Factorial Key

- Press this key (and a numeric key) to add the displayed value to the value in the M*n* register.
- Following [SHIFT], press this key to calculate the factorial of the displayed value ($x!$).

*Press a memory key [M+], [M−], [MR], [Min], [X↔M] to display the key character and the prompt for input of a 2-digit value for the memory address. After the memory address is entered, the display returns to the previous display. Memory F can be addressed simply by pressing [EXP] for the memory address.

ALL RESET общий сброс

ALL RESET Button

This button deletes all memory when it is pressed while the unit is switched ON. Press the button with the tip of a pointed object to delete all programs and data contained in memory. At this time, the unit enters its default setting, which is RUN, COMP, DEG. If you find that the memory was not cleared when you pressed the ALL RESET button, press the P button and then press the ALL RESET button again.

P

P Button

Press the P button for partial reset when normal operation of your unit has been prevented by strong electrostatic charge. Partial reset retains memory contents.

Before Beginning Calculations

The unit must be in the RUN mode (MODE 1) to perform calculations. A unit of angular measurement may be displayed even when a calculation does not involve an angle.

■Calculation Priority Sequence

- This unit performs calculations in accordance with the following calculation priority sequence:

① Functions
② x^y, $x^{1/y}$, R→P, P→R
③ ×, ÷
④ +, −
⑤ AND
⑥ OR, XOR } (BASE-N mode only)

When the priority is the same, calculation is performed from left to right. Expressions contained in parentheses have the highest priority.

- Register L_1 through L_{12} can be used to store up to 12 levels of parentheses or low priority display.
- Three sets of parentheses can be used in each level, thereby allowing nesting up to 36 sets.

*Determining the Number of Levels and L Registers (Example with 4 levels with 5 sets of parentheses)

Calculation Example $2\times(((3+4\times((5+4)\div3))\div5)+9)=$

Operations 2 × (((3 + 4 × ((5 + 4) ÷ 3)) ÷ 5) + 9) =

1 level 1 level 1 level 1 level A

Register contents at point A

x	4
L_1	((5 +
L_2	4 ×
L_3	(((3 +
L_4	2 ×
L_5	
L_6	
⋮	

■ Correcting Input Errors

- Mistakes in entering calculation data (registration errors) can be corrected immediately if you press [C] key and re-enter the correct data before you press a calculation command key.
- Incorrect results obtained by function calculations and parentheses calculations that are to be used in a succeeding calculation can be corrected by pressing [C] and recalculating. Calculation can then continue normally.
- Mistakes in pressing [+], [−], [×], [÷], [SHIFT] [x^2], or [SHIFT] [$\sqrt{\ }$] keys can be corrected by immediately pressing the proper command key. Even though this changes the command, the calculation priority sequence is not changed.

■ Overflows and Calculation Errors

If the calculation range of the unit is exceeded, an error message ("Error" or "( ) Error") appears on the display and further operation is impossible. This is the ***error check function***. The following conditions result in errors:

1. Any result, intermediate or final, or any value in memory that exceeds a value of $\pm 9.999999999 \times 10^{99}$.
2. Any attempt to perform a function calculation that exceeds the input range. (See page 95.)
3. Improper standard deviation calculations.
   Ex. Attempting to calculate $\bar{x}$ or $x\sigma n$ without input data.

*"Error" is displayed for any of the above conditions. Press [AC] key to cancel error check and try again.

4. When the number of levels exceeds 12 or nesting exceeds 36.
   Ex. Entering thirty-four successive [(]'s followed by 2[+]3[×]

*"( ) Error" is displayed for the above condition. Press [C] key to display the value that existed immediately before the error and continue the calculation. You can also press [AC] key and perform the operation from the beginning.

*Results with a value less than $\pm(1 \times 10^{-99})$ do not produce error messages, but are changed to "0".

Basic Calculations

■Arithmetic Operations

•Press the keys in the same order as the formula to perform arithmetic operations.

Example	Operation	Display
$23+4.5-53=-25.5$	23 [+] 4·5 [−] 53 [=]	- 25.5
$56\times(-12)\div(-2.5)=268.8$	56 [×] 12 [+/−] [÷] 2·5 [+/−] [=]	268.8
*For negative values, press [+/−] after entering the value.		
$12369\times7532\times74103=$ 6.903680613×10^{12} $(=6903680613000)$	12369 [×] 7532 [×] 74103 [=]	6.903680613 12
$1.23\div90\div45.6=2.997076023\times10^{-4}$ $(=0.0002997076023)$	1·23 [÷] 90 [÷] 45·6 [=]	2.997076023 -04
*Results greater than 10^{10} (10 billion) or less than 10^{-2} (0.01) are displayed in exponential form.		
$(4.5\times10^{75})\times(-2.3\times10^{-78})=-0.01035$ $=-10.35\times10^{-3}$	4·5 [EXP] 75 [×] 2·3 [+/−] [EXP] 78 [+/−] [=] (Exponential conversion) [ENG]	-0.01035 -10.35 -03
*Results from 10^{-2} to 10^{10} are not displayed in exponential form. Use [ENG] to display results in exponential form. (See page 16.)		
$(2+3)\times10^{2}=500$	[(] 2 [+] 3 [)] [×] 1 [EXP] 2 [=]	500.
*The operational sequence, [(] 2 [+] 3 [)] [EXP] 2, does not yield the correct result. Be sure to insert [×] 1 operation between [)] and [EXP].		
$(1\times10^{5})\div7=14285.71429$	1 [EXP] 5 [÷] 7 [=]	14285.71429
$(1\times10^{5})\div7-14285=0.7142857$	(Continuing) [−] 14285 [=]	0.7142857
*Calculations are performed using 12 digits for the mantissa. Although results are displayed rounded off to 10 digits, the 12-digit mantissa is maintained in the register.		

•For mixed arithmetic calculations, multiplication and division are given priority over addition and subtraction.

Example	Operation	Display
$3+\underline{5\times6}=33$	3 [+] 5 [×] 6 [=]	33.
$\underline{7\times8}-\underline{4\times5}=36$	7 [×] 8 [−] 4 [×] 5 [=]	36.
$1+2-\underline{3\times4\div5}+6=6.6$	1 [+] 2 [−] 3 [×] 4 [÷] 5 [+] 6 [=]	6.6

■Parentheses Calculations

- Calculations can be performed up to 12 levels, nested with up to 36 sets of parentheses (see page 18).
- Once an open parenthesis ([(]) sets the display to 0., it also displays the number of parentheses. A close parenthesis ([)]) displays the result of an operation enclosed in parentheses.

Example	Operation	Display
$100-\underline{(2+3)\times 4}=80$	100 [−] [(] 2 [+] 3 [)]	5.
	(Continuing) [×] 4 [=]	80.
$(2+3)\times(4+5)=45$	2 [+] 3 [)] [×] [(] 4 [+] 5 [=]	45.

*The open parentheses at the beginning of an expression and the close parentheses immediately before [=] may be omitted, no matter how many are required.

$10-\{2+7\times(3+6)\}=-55$	10 [−] [(] 2 [+] 7 [×] [(] 3 [+] 6 [=]	−55.
$\{(2+3)\times 4-(5+6)\times 3\}\times 2=-26$	2 [+] 3 [)] [×] 4 [−] [(] 5 [+] 6 [)] [×] 3 [)] [×] 2 [=]	−26.
$\frac{2\times 3+4}{5}=(2\times 3+4)\div 5=2$	2 [×] 3 [+] 4 [)] [÷] 5 [=]	2.

*An [=] can be used instead of a [)] in the above example.

$\frac{2}{3}\left(\frac{8}{10}-\frac{1}{2}\right)=0.2$	2 [÷] 3 [×] [(] 8 [÷] 10 [−] 1 [÷] 2 [)] [=]	0.2
$\frac{5\times 6+6\times 8}{15\times 4+12\times 3}=0.8125$ $=(5\times 6+6\times 8)\div(15\times 4+12\times 3)$	[(] 5 [×] 6 [+] 6 [×] 8 [)] [÷] [(] 15 [×] 4 [+] 12 [×] 3 [)] [=]	0.8125

*Convert calculation formulas with complex fractions to a one line expression with parentheses before performing the operation.

$(1.2\times 10^{19})-\{(2.5\times 10^{20})\times\frac{3}{100}\}=4.5\times 10^{18}$	1·2 [EXP] 19 [−] [(] 2·5 [EXP] 20 [×] 3 [÷] 100 [)] [=]	4.5 18
$\frac{6}{4\times 5}=0.3$	4 [×] 5 [÷] 6 [SHIFT] [x⇔y] [=] (↑ Register conversion)	0.3

*The above example is the same as: 6 [÷] [(] 4 [×] 5 [)] [=] and 6 [÷] 4 [÷] 5 [=].

■Constant Calculations

•Press an arithmetic operation key twice in succession to specify the displayed value as a constant. "K" appears on the display and the value can be recalled thereafter with a "value [=]" operation.

Example	Operation	Display
$12+\underline{23}=35$	23 [+] [+] 12 [=]	35.
$45+\underline{23}=68$	45 [=]	68.
$(-78)+\underline{23}=-55$	78 [+/-] [=]	-55.
$7-\underline{5.6}=1.4$	5·6 [−] [−] 7 [=]	1.4
$2.9-\underline{5.6}=-2.7$	2·9 [=]	-2.7
$(8.5\times10^{3})-\underline{5.6}=8494.4$	8·5 [EXP] 3 [=]	8494.4
$2.3\times\underline{12}=27.6$	12 [×] [×] 2·3 [=]	27.6
$(-4.56)\times\underline{12}=-54.72$	4·56 [+/-] [=]	-54.72
$\frac{5}{8}\times\underline{12}=7.5$	[(] 5 [÷] 8 [)] [=]	7.5
$78\div\underline{9.6}=8.125$	9·6 [÷] [÷] 78 [=]	8.125
$(1.2\times10^{15})\div\underline{9.6}=1.25\times10^{14}$	1·2 [EXP] 15 [=]	1.25 14
$45\div\underline{9.6}=4.6875$	45 [=]	4.6875
$\underline{3\times6}\times9=162$	3 [×] 6 [×] [×] 9 [=]	162.
$\underline{3\times6}\times8=144$	8 [=]	144.
$\underline{3\times6}\times(5+6)=198$	[(] 5 [+] 6 [)] [=]	198.
$\{(1.1^{3})^{2}\}^{2}=3.138428377$	1·1 [×] [×] [=] [=]	1.331 (cube)
	[×] [=] [×] [=]	3.138428377
$17+17+17+17=68$	17 [+] [+] [=] [=] [=]	68.
$8+8+8+11+11+11=57$	8 [+] [+] [=] [=] [+] [+] 11 [SHIFT] [x⇄y] [=] [=] [=]	57.
$50-3.6-3.6-3.6-3.6=35.6$	50 [−] [−] 3·6 [SHIFT] [x⇄y] [=] [=] [=] [=]	35.6
	(or 3·6 [−] [−] 50 [=] [=] [=] [=])	
$\frac{56}{4\times(2+3)}=2.8$	4 [×] [(] 2 [+] 3 [)] [÷] [÷]	20. (denominator)
	56 [=]	2.8

*[÷] [÷] and [−] [−] are equivalent to the register conversion ([SHIFT] [x⇄y]) function.

■ Memory Calculations

- This unit is provided with 110 memories.
- There are five memory keys ([x↔M], [Min], [M−], [M+], [MR]).
- Press a memory key to display the key character and the prompt for input of a 2-digit value for the memory address. After the memory address is entered, the display returns to the previous display. Memory F can be addressed simply by pressing [EXP F] for the memory address.
- Memory registers hold 12-digit internal values, rather than the 10-digit mantissa displayed.
- The contents of memories are not erased when power is switched OFF. Press [2ndF] followed by [MAC] to clear memories.

Example	Operation	Display
23+9=32	23 [+] 9 [=] [Min] [0] [1]	32.
53−6=47	53 [−] 6 [=] [M+] [0] [1]	47.
−) 45×2=90	45 [×] 2 [=] [M−] [0] [1]	90.
99÷3=33	99 [÷] 3 [=] [M+] [0] [1]	33.
Total 22	[MR] [0] [1]	22.

*Use [Min] to input an initial value in memory. Clearing a memory before input is not necessary.

7+7+7+(2×3)+(2×3)	7 [Min] [EXP F] [M+] [EXP F] [M+] [EXP F] 2 [×] 3 [=] [M+] [EXP F] [M+] [EXP F]	
+(2×3)−(2×3)=33	[M+] [EXP F] [M−] [EXP F] [MR] [EXP F]	33.
7+8+9=24	7 [Min] [0] [1] [+] 8 [Min] [0] [2] [+] 9 [Min] [0] [3] [=] [Min] [0] [4]	24.
4+5+6=15	4 [M+] [0] [1] [+] 5 [M+] [0] [2] [+] 6 [M+] [0] [3] [=] [M+] [0] [4]	15.
3+6+9=18	3 [M+] [0] [1] [+] 6 [M+] [0] [2] [+] 9 [M+] [0] [3] [=] [M+] [0] [4]	18.
(Total) 14 19 24 57	[MR] [0] [1]	14.
	[MR] [0] [2]	19.
	[MR] [0] [3]	24.
	[MR] [0] [4]	57.
7×4×12.3=344.4	7 [×] 4 [×] 12·3 [Min] [0] [1] [=]	344.4
−12.3×(8+5)=−159.9	[MR] [0] [1] [+/−] [×] [(] 8 [+] 5 [)] [=]	−159.9
(12.3+6)×9=164.7	[(] [MR] [0] [1] [+] 6 [)] [×] 9 [=]	164.7
12×(2.3+3.4)−5=63.4	12 [×] [(] 2·3 [+] 3·4 [)] [Min] [EXP F] [−] 5 [=]	63.4
√ 30×(2.3+3.4+4.5)−15×4.5=238.5	4·5 [M+] [EXP F] [x↔M] [EXP F] [×] 30 [−] 15 [×] [MR] [EXP F] [=]	238.5
	↑ Displayed value 4.5 switched with contents of memory	

Function Calculations

- Enter data and press the respective command key to perform function calculations.
- The result obtained for a function can used for further calculations, in arithmetic operations and parentheses calculations.
- See conditions on page 95 for function input range and precision.

■ Trigonometric (sin, cos, tan, cot, sec, cosec) and Inverse Trigonometric ($\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$) Functions

Example	Operation	Display
$14°25'36" = 14.42666667°$	14 ° ' " 25 ° ' " 36 ° ' "	14.42666667
$12.3456° = 12°20'44.16"$	12 • 3456 SHIFT ° ' "	12°20'44.16"
*For sexagesimal displays, the total number of digits for display of degrees/minutes/seconds is eight digits or less.		
$\sin 63°52'41" = 0.897859012$	MODE 4 (DEG) 63 ° ' " 52 ° ' " 41 ° ' " sin	0.89785012
$\cos(\frac{\pi}{3}\text{rad}) = 0.5$	MODE 5 (RAD) π EXP ÷ 3 = cos	0.5
$\tan(-35\text{grad}) = -0.612800788$	MODE 6 (GRA) 35 +/- tan	0.612800788
$2 \cdot \sin 45° \times \cos 65° =$ 0.597672477	"DEG" 2 × 45 sin × 65 cos =	0.597672477
$\cot 30° = \frac{1}{\tan 30°} = 1.7320508$	"DEG" 30 tan SHIFT $1/x$	1.732050808
$\sec(\frac{\pi}{3}\text{rad}) = \frac{1}{\cos(\pi/3\text{rad})}$ $= 2$	"RAD" ÷ 3 = cos SHIFT $1/x$	2.
$\text{cosec}\, 30° = \frac{1}{\sin 30°} = 2$	"DEG" 30 sin SHIFT $1/x$	2.
$\sin^{-1} 0.5 = 30°$ (Calculate the value of x when $\sin x = 0.5$.)	"DEG" • 5 SHIFT sin	30.
$\cos^{-1}\frac{\sqrt{2}}{2} = 0.785398163\text{rad}$ $= \frac{\pi}{4}\text{rad}$	"RAD" 2 SHIFT √ ÷ 2 = SHIFT cos ÷ π EXP =	0.785398163 0.25
$\tan^{-1} 0.741 = 36.53844577°$ $= 36°32'18.4"$	"DEG" • 741 SHIFT tan SHIFT ° ' "	36.53844577 36°32'18.4"
$2.5 \times (\sin^{-1} 0.8 - \cos^{-1} 0.9) =$ $68°13'13.53"$	"DEG" 2 • 5 × (• 8 SHIFT sin − • 9 SHIFT cos) = SHIFT ° ' "	68°13'13.53"

■Logarithmic (log, ln) and Exponential (10^x, e^x, x^y, $x^{1/y}$) Functions

Example	Operation	Display
$\log 1.23 (= \log_{10} 1.23) = 0.089905111$	1·23 [log]	0.089905111
$\ln 90 (= \log_e 90) = 4.49980967$	90 [ln]	4.49980967
$\log 456 \div \ln 456 = 0.434294481$ (log/ln ratio = constant M)	456 [Min] [EXP F] [log] [÷] [MR] [EXP F] [ln] [=]	0.434294481
√ $4^x = 64$ (Calculate the value of x.) from $x \cdot \log 4 = \log 64$ $x = \frac{\log 64}{\log 4} = 3$	64 [log] [÷] 4 [log] [=]	3.
$10^{1.23} = 16.98243652$ (Calculate the antilogarithm of common logarithm 1.23.)	1·23 [SHIFT] [10^x]	16.98243652
$e^{4.5} = 90.0171313$ (Calculate the antilogarithm of natural logarithm 4.5.)	4·5 [SHIFT] [e^x]	90.0171313
$10^4 \cdot e^{-4} + 1.2 \cdot 10^{2.3} =$ 422.5878667	1 [EXP] 4 [×] 4 [+/-] [SHIFT] [e^x] [+] 1·2 [×] 2·3 [SHIFT] [10^x] [=]	422.5878667
$5.6^{2.3} = 52.58143837$	5·6 [SHIFT] [x^y] 2·3 [=]	52.58143837
$123^{\frac{1}{7}} (= \sqrt[7]{123}) = 1.988647795$	123 [SHIFT] [$x^{1/y}$] 7 [=]	1.988647795
$4^{\underline{2.5}} = 32$	2·5 [SHIFT] [x^y] [SHIFT] [x^y] 4 [=]	32.
$0.16^{\underline{2.5}} = 0.01024$	[·] 16 [=]	0.01024.
$9^{\underline{2.5}} = 243$	9 [=]	243.
*x^y and $x^{1/y}$ can also be performed for constant calculations.		
$(78-23)^{-12} = 1.305111829 \times 10^{-21}$	[(] 78 [−] 23 [)] [SHIFT] [x^y] 12 [+/-] [=]	1.305111829 -21
$2 + \underline{3 \times 64^{\frac{1}{3}}} - 4 = 10$	2 [+] 3 [×] 64 [SHIFT] [$x^{1/y}$] 3 [−] 4 [=]	10.
*x^y and $x^{1/y}$ are given calculation priority over × and ÷.		
$2^2 + 3^3 + 4^4 = 287$	2 [SHIFT] [x^y] 2 [+] 3 [SHIFT] [x^y] 3 [+] 4 [SHIFT] [x^y] 4 [=]	287.

$10^{5.1}+9^{5.1}+e^{5.1}=$	5·1 SHIFT x^y SHIFT x^y 10 = Min EXP F	
199615.7294	9 = M+ EXP F 1 SHIFT e^x = M+ EXP F MR EXP F	199615.7294
	(5·1 SHIFT 10^x + 9 SHIFT x^y 5·1 + 5·1 SHIFT e^x = produces same result)	
$2\times 3.4^{(5+6.7)}=3306232.001$	2 × 3·4 SHIFT x^y (5 + 6·7) =	3306232.001
$\log\sin 40^\circ+\log\cos 35^\circ=$		
−0.27856798	MODE 4 (“DEG”) 40 sin log + 35 cos log =	−0.278567983
Antilogarithm = 0.526540784	(Continuing) SHIFT 10^x	0.526540784
(sin 40° × cos 35° logarithm calculation)		

■Hyperbolic (sinh, cosh, tanh) and Inverse Hyperbolic ($\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$) Functions

Example	Operation	Display
$\sinh 3.6=18.28545536$	3·6 hyp sin	18.28545536
$\tanh 2.5=0.986614298$	2·5 hyp tan	0.986614298
$\cosh 1.5-\sinh 1.5=0.22313016$	1·5 Min EXP F hyp cos −	2.352409615
$=e^{-1.5}$	MR EXP F hyp sin =	0.22313016
(Proof of $\cosh x \pm \sinh x = e^{\pm x}$)	(Continuing) ln	−1.5
$\sinh^{-1}30=4.094622224$	30 SHIFT hyp $\sin^{-1}$	4.094622224
$\cosh^{-1}\left(\frac{20}{15}\right)=0.795365461$	20 ÷ 15 = SHIFT hyp $\cos^{-1}$	0.795365461
What is x when $\tanh 4x = 0.88$?		
$x=\frac{\tanh^{-1}0.88}{4}=0.343941914$	. 88 SHIFT hyp $\tan^{-1}$ ÷ 4 =	0.343941914
$\sinh^{-1}2\times\cosh^{-1}1.5=$	2 SHIFT hyp $\sin^{-1}$ ×	
1.389388923	1·5 SHIFT hyp $\cos^{-1}$ =	1.389388923

■Other Functions ($\sqrt{\ }$, x^2, $^1/_x$, $x!$, RAN#, ABS, INT, FRAC)

Example	Operation	Display
$\sqrt{2}+\sqrt{5}=3.65028154$	2 SHIFT $\sqrt{\ }$ + 5 SHIFT $\sqrt{\ }$ =	3.65028154
$2^2+3^2+4^2+5^2=54$	2 SHIFT x^2 + 3 SHIFT x^2 + 4 SHIFT x^2 + 5 SHIFT x^2 =	54.
$\frac{1}{\frac{1}{3}-\frac{1}{4}}=12$	3 SHIFT $1/x$ − 4 SHIFT $1/x$ = SHIFT $1/x$	12.
$8!\,(=1\times2\times3\times\cdots\cdots\times7\times8)=40320$	8 SHIFT $x!$	40320.
Random number generation (pseudo random numbers from 0.000 to 0.999)	SHIFT RAN#	(Example) 0.570
$\sqrt{13^2-5^2}+\sqrt{3^2+4^2}=17$	(13 SHIFT x^2 − 5 SHIFT x^2) SHIFT $\sqrt{\ }$ + (3 SHIFT x^2 + 4 SHIFT x^2) SHIFT $\sqrt{\ }$ =	40.
$\sqrt{1-\sin^2 40^\circ}=0.766044443$ $=\cos 40^\circ$ (Explanation $\cos\theta=\sqrt{1-\sin^2\theta}$)	MODE 4 (DEG) 1 − 40 sin SHIFT x^2 = SHIFT $\sqrt{\ }$ (Continuing) SHIFT cos	0.766044443 40.
$1/2!+1/4!+1/6!+1/8!=$ 0.543080357	2 SHIFT $x!$ SHIFT $1/x$ + 4 SHIFT $x!$ SHIFT $1/x$ + 6 SHIFT $x!$ SHIFT $1/x$ + 8 SHIFT $x!$ SHIFT $1/x$ =	0.543080357
${}_{10}P_4=\frac{10!}{(10-4)!}=5040$	10 SHIFT $x!$ ÷ (10 − 4) SHIFT $x!$ =	5040.
${}_{12}C_5=\frac{12!}{5!(12-5)!}=792$	12 SHIFT $x!$ ÷ (5 SHIFT $x!$ × (12 − 5) SHIFT $x!$) =	792.
Absolute value of the common logarithm of $\frac{3}{4}$ =		
$\lvert\log\frac{3}{4}\rvert=0.124938736$	3 ÷ 4 = log SHIFT ABS	0.124938736
Integer portion of $\frac{7800}{96}$ = 81	7800 ÷ 96 = SHIFT INT	81.
Decimal portion of $\frac{7800}{96}$ = 0.25	7800 ÷ 96 = SHIFT FRAC	0.25
What is the aliquot part of 2512549139 ÷ 2141?	2512549139 ÷ 2141 = (Continuing) SHIFT FRAC	1173540. 0.99953

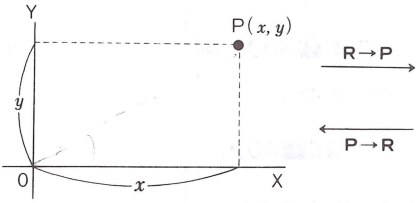
■Fraction Calculations

•Enter fractions in the sequence of integer, numerator and denominator. Values are displayed in the same order. Ten digits, including separator marks (⌟), can be entered.

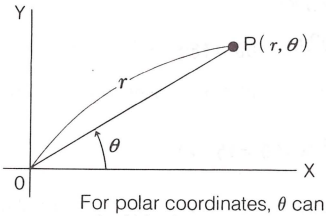
Example	Operation	Display
$\frac{2}{5}+3\frac{1}{4}=3\frac{13}{20}$	2 a⅝ 5 + 3 a⅝ 1 a⅝ 4 =	3⌟13⌟20.
$=3.65$	(Decimal conversion) a⅝	3.65
*Fractions can be converted to decimals. Immediately after a fraction has been converted to a decimal, it can be changed back to fraction.		
$3\frac{456}{78}=8\frac{11}{13}$ (Reduction)	3 a⅝ 456 a⅝ 78 =	8⌟11⌟13.
	(Continuing) SHIFT d/c	115⌟13.
*Press a calculation command key to reduce fractions and improper fractions to their lowest terms. Press SHIFT d/c to change a fraction that has been reduced to lowest terms to an improper fraction.		
$\frac{1}{2578}+\frac{1}{4572}$		
$=6.066202547\times10^{-4}$	1 a⅝ 2578 + 1 a⅝ 4572 =	6.066202547^{-04}
*A decimal value is automatically displayed if the total number of digits for the integer, numerator, denominator and separation marks exceeds ten.		
$\frac{1}{2}\times0.5=0.25$	1 a⅝ 2 × . 5 =	0.25
*The unit uses decimal values to calculate fractions and decimals.		
$\frac{1}{3}\times(-\frac{4}{5})-\frac{5}{6}=-1\frac{1}{10}$	1 a⅝ 3 × 4 a⅝ 5 +/-	
	− 5 a⅝ 6 =	-1⌟1⌟10.
$\frac{1}{2}\times\frac{1}{3}+\frac{1}{4}\times\frac{1}{5}=\frac{13}{60}$	1 a⅝ 2 × 1 a⅝ 3 +	
	1 a⅝ 4 × 1 a⅝ 5 =	13⌟60.

■Coordinate Conversion (R→P, P→R)

•Rectangular Coordinates



•Polar Coordinates



For polar coordinates, θ can be calculated within the range $-180° < \theta \leqq 180°$. (The calculation range for radians and grads is the same.)

Example	Operation	Display
If $x=14$ and $y=20.7$, what are r and θ?	MODE 4 ("DEG") 14 SHIFT R→P 20·7 =	55.92839019 (θ) (Upper display) 24.98979792 (r) (Lower display)
	(Continuing) SHIFT X⇔Y SHIFT ...	55° 55' 42.2" (θ)
If $x=7.5$ and $y=-10$, what are r and θ rad?	MODE 5 ("RAD") 7·5 SHIFT R→P 10 +/- =	-0.927295218 (θ) 12.5 (r)
If $r=25$ and $\theta=56°$, what are x and y?	"DEG" 25 SHIFT P→R 56 =	20.72593931 (y) 13.97982259 (x)
If $r=4.5$ and $\theta=\frac{2}{3}\pi$ rad, what are x and y?	"RAD" 4·5 SHIFT P→R (2 ÷ 3 × π) =	3.897114317 (y) -2.25 (x)

■Percents

Example	Operation	Display
•Proportion What is 17% of 1500 cc? $1500 \times \frac{17}{100} = 255$ (cc)	1500 × 17 SHIFT %	255.
•Premium What is a 15% increase on 620 g? $620 + 620 \times \frac{15}{100} = 713$ (g)	620 × 15 SHIFT % +	713.
•Discount What is a 4% discount of 7.53 V? $7.53 - 7.53 \times \frac{4}{100} = 7.2288$ (V)	7·53 × 4 SHIFT % −	7.2288
•Ratio What percent of 9.8 m is 7.8 m? $\frac{7.8}{9.6} \times 100 = 81.25$ (%)	7·8 ÷ 9·6 SHIFT %	81.25

•Rate of Change

1) If you add 300 g to a 500 g sample, what percentage of the old sample is the new sample?

$\frac{300+500}{500} \times 100 = 160$ (%)

300 [+] 500 [SHIFT] [%] → 160.

2) If a temperature of 40°C increases to 46°C, what is the percentage of increase?

$\frac{46-40}{40} \times 100 = 15$ (%)

46 [−] 40 [SHIFT] [%] → 15.

3) If a 500 cc solution decreases to 400 cc, what is the percentage of decrease?

$\frac{400-500}{500} \times 100 = -20$ (%)

400 [−] 500 [SHIFT] [%] → −20.

•Percent Constant

1) 15% of 1500 g = 225 g
23% of 1500 g = 345 g
25% of 1500 g = 375 g

1500 [×] [×] 15 [SHIFT] [%] → 225.
(Continuing) 23 [SHIFT] [%] → 345.
(Continuing) 25 [SHIFT] [%] → 375.

2) 30 g = 15.625% of 192 g
156 g = 81.25% of 192 g

192 [÷] [÷] 30 [SHIFT] [%] → 15.625
156 [SHIFT] [%] → 81.25

3) Adding 600 g to 1200 g = 150% of original weight
Adding 510 g to 1200 g = 142.5% of original weight

1200 [+] [+] 600 [SHIFT] [%] → 150.
510 [SHIFT] [%] → 142.5

4) 138 g = 8% decrease from 150 g
156 g = 4% decrease from 150 g

150 [−] [−] 138 [SHIFT] [%] → −8.
156 [SHIFT] [%] → 4.

■Specification of Number of Significant Digits, Number of Decimal Places, and Floating Decimals (RND, FIX, ENG)

Example	Operation	Display
100 ÷ 6 = 16.66666666·····	100 [÷] 6 [=]	16.66666667
	(4 significant digits specified) [SHIFT] [RND] 4	1.667 01
	(5 decimal places specified) [SHIFT] [RND] [FIX] 5	16.66667

*Specification governs rounding and display digits for values. However, original values (un-rounded) are retained in the registers. Specify the number of significant digits for exponential display.

200 ÷ 7 × 14 = 400	200 [÷] 7 [=] [SHIFT] [RND] [FIX] 3	28.571
	(Continuing) [×] 14 [=]	399.994

*Use the display value to continue calculation after a specification has been made.

123 m × 456 = 56088 m	123 [×] 456 [=]	56088.
= 56.088 km	[ENG]	56.088 03
7.8 g ÷ 96 = 0.08125 g	7·8 [÷] 96 [=]	0.08125
= 81.25 mg	[ENG]	81.25 −03

Binary, Octal, Decimal and Hexadecimal Calculations

- Perform binary, octal, decimal and hexadecimal calculations, conversions, and logical operations in the BASE-N mode ([MODE] [−]).
- Press [SHIFT] followed by [BIN], [OCT], [DEC], or [HEX] to specify the number system (binary, octal, decimal, hexadecimal, respectively).

•Calculation Range

Binary (16 digits)
Positive: $0 \leqq x \leqq 0111111111111111$
Negative: $1000000000000000 \leqq x \leqq 1111111111111111$
Numbers: 0, 1

Octal (11 digits)
Positive: $0 \leqq x \leqq 17777777777$
Negative: $20000000000 \leqq x \leqq 37777777777$
Numbers: 0, 1, 2, 3, 4, 5, 6, 7

Decimal (10 digits)
Positive: $0 \leqq x \leqq 2147483647$
Negative: $-2147483648 \leqq x \leqq -1$
Numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Hexadecimal (8 digits)
Positive: $0 \leqq x \leqq 7FFFFFFF$
Negative: $80000000 \leqq x \leqq FFFFFFFF$
Numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

*Numbers other than those listed above cannot be entered. For example, [8] [9] cannot be entered when using octal numbers.
*Mode specification for the unit of angular measurement or number of display digits cannot be made in the BASE-N mode. Exit the BASE-N mode to perform specification.

2 8 10 16

■Binary, Octal, Decimal and Hexadecimal Conversions

Example	Operation	Display
	[MODE] [−] (Specify BASE-N mode)	
What is the binary value of 22_{10}?	[DEC] 22 [SHIFT] [BIN]	0000000000010110
What is the octal value of 22_{10}?	[SHIFT] [OCT]	00000000026
What is the hexadecimal value of 22_{10}?	[HEX]	00000016
What is the binary value of 98765_{10}?	[DEC] 98765 [SHIFT] [BIN]	Error

*Conversions that involve changing from a larger calculation range to a smaller calculation range are sometimes impossible.

What is the decimal value of $7FFFFFF_{16}$?	[HEX] 7FFFFFF [DEC]	134217727
What is the decimal value of 4000000000_8?	[SHIFT] [OCT] 4000000000 [DEC]	536870912
What is the octal value of 123_{10}?	[DEC] 123 [SHIFT] [OCT]	00000000173
What is the decimal value of 1100110_2?	[SHIFT] [BIN] 1100110 [DEC]	102

■Negative Expressions

•Press [+/-] to change a value to negative. Negative values are two's complements in binary, octal and hexadecimal.

Example	Operation	Display
	[MODE] [−] (Specify BASE-N mode)	
How is 1010_2 expressed as a negative?	[SHIFT] [BIN] 1010 [NEG]	1111111111110110
What is the decimal value of 1010_2?	[DEC]	-10
How is 1_2 expressed as a negative?	[SHIFT] [BIN] 1 [NEG]	1111111111111111
How is 2_8 expressed as a negative?	[SHIFT] [OCT] 2 [NEG]	37777777776
How is 34_{16} expressed as a negative?	[HEX] 34 [NEG]	FFFFFFCC

■Binary, Octal, Decimal and Hexadecimal Calculations

Example	Operation	Display
	[MODE] [−] (Specify BASE-N mode)	
$10111_2+11010_2=110001_2$	[SHIFT] [BIN] 10111 [+]	
	11010 [=]	0000000000110001
$123_8\times ABC_{16}=37AF4_{16}$	[SHIFT] [OCT] 123 [×] [HEX] ABC [=]	00037AF4
$=228084_{10}$	[DEC]	228084
$1F2D_{16}-100_{10}=7881_{10}$	[HEX] 1F2D [−] [DEC] 100 [=]	7881
$=1EC9_{16}$	[HEX]	00001EC9
$7654_8\div 12_{10}=334.3\cdots\cdots$	[SHIFT] [OCT] 7654 [÷] [DEC] 12 [=]	334
$=516_8$	[SHIFT] [OCT]	00000000516
*Decimal portions of calculation results are cut off.		
$110_2+456_8\times 78_{10}\div 1A_{16}$	[SHIFT] [BIN] 110 [+] [SHIFT] [OCT] 456	
$=390_{16}$	[×] [DEC] 78 [÷] [HEX] 1A [=]	00000390
$=912_{10}$	[DEC]	912
*Multiplication and division have calculation priority over addition and subtraction for mixed calculations.		
$BC_{16}\times(14_{10}+69_{10})$	[HEX] BC [×]	
$=15604_{10}$	[SHIFT] [(] [DEC] 14 [+] 69 [SHIFT] [)] [=]	15604
$=3CF4_{16}$	[HEX]	00003CF4
$23_8+963_{10}=982_{10}$	[SHIFT] [OCT] 23 [Min] [EXP] [F] [+] [DEC] 963 [=]	982
$23_8+101011_2=111110_2$	[MR] [EXP] [F] [+] [SHIFT] [BIN] 101011 [=]	0000000000111110

Example	Operation	Display
$2A56_{16} \times 23_8 = 32462_{16}$	HEX 2A56 × MR EXP F =	00032462
$2B_{16} \times CD_{16} = 226F_{16}$	HEX 2B × × CD =	0000226F
$2B_{16} \times 58_{10} = 2494_{10}$	DEC 58 =	2494
$2B_{16} \times 63_8 = 4221_8$	SHIFT OCT 63 =	00000004221

*Constant calculations can be performed the same as ×, − and ÷ on page 22.

■ Logical Operations

•Preform logical operations in binary, octal, and hexadecimal using AND, OR, XOR, and NOT keys. Use AND for logical product, OR key for logical sum, XOR key for exclusive logical sum, and NOT key for negation.

Example	Operation	Display
	MODE − (Specify BASE-N mode)	
19_{16} AND $1A_{16} = 18_{16}$	HEX 19 AND 1A =	00000018
1110_2 AND $36_8 = 1110_2$ AND	SHIFT BIN 1110 SHIFT OCT AND 36 =	00000000016
	SHIFT BIN	00000000001110
23_8 OR $61_8 = 63_8$	SHIFT OCT 23 OR 61 =	00000000063
120_{16} OR $1101_2 = 12D_{16}$	HEX 120 OR SHIFT BIN 1101 =	0000000100101101
	HEX	0000012D
5_{16} XOR $3_{16} = 6_{16}$	HEX 5 XOR 3 =	00000006
1010_2 AND (A_{16} OR 7_{16})	BIN 1010 AND SHIFT (HEX A OR	
$= 1010_2$	7 SHIFT) =	0000000A
	SHIFT BIN	000000000001010
$1A_{16}$ AND $2F_{16} = A_{16}$	HEX 2F AND AND 1A =	0000000A
$3B_{16}$ AND $2F_{16} = 2B_{16}$	3B =	0000002B
Negation of 10110_2	SHIFT BIN 10110 NOT	1111111111101001
Negation of 1234_8	SHIFT OCT 1234 NOT	37777776543
Negation of $2FFFED_{16}$	HEX 2FFFED NOT	FFD00012

Standard Deviation Calculations

- Standard deviation calculations can be performed after clearing data totalizer memories M_{07}, M_{08}, and M_{09}. Following [SHIFT], press [SAC] to clear data totalizer memories M_{07}, M_{08}, and M_{09}.
- If memories M_{07}, M_{08}, and M_{09} are not used during a standard deviation calculation, all other calculations can be performed (including program calculations).

■Data Input and Calculation Formulas

- Input individual data items by entering the data followed by [x_{01}] key.
- Multiple data of the same value can be input by pressing [x_{01}] key the same number of times the data is repeated, or by entering the data first, followed by [×] key, a value representing the number of times the data is repeated, and then [x_{01}] key. Decimal numbers can also be input with these methods (Graphic analysis, probability distribution, etc.).

•Standard Deviation

$$\sigma_n = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}} = \sqrt{\frac{\Sigma x^2-(\Sigma x)^2/n}{n}}$$

[Uses all data of a finite population to determine the standard deviation for the population.]

$$\sigma_{n-1} = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}} = \sqrt{\frac{\Sigma x^2-(\Sigma x)^2/n}{n-1}}$$

[Uses sample data of a population to estimate the standard deviation for the population.]

•Mean

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{\Sigma x}{n}$$

Example	Operation	Display
Data 55, 54, 51, 55, 53, 53, 54, 52	[AC] [SHIFT] [SAC] 55 [x_{01}] 54 [x_{01}] 51 [x_{01}] 55 [x_{01}]	
	53 [x_{01}] [x_{01}] 54 [x_{01}] 52 [x_{01}]	52.
	(Standard deviation σ_n) [SHIFT] [σ_n]	1.316956719
	(Standard deviation σ_{n-1}) [SHIFT] [σ_{n-1}]	1.407885953
	(Mean $\bar{x}$) [SHIFT] [$\bar{x}$]	53.375
	(Number of data n) [MR] [0] [9]	8.
*Results may be obtained in any order desired.	(Sum of Σx) [MR] [0] [8]	427.
	(Sum of squares Σx^2) [MR] [0] [7]	22805.
What is the deviation of the unbiased variance, the difference between each datum, and the mean of the above data?	(Continuing) [SHIFT] [σ_{n-1}] [SHIFT] [x^2]	1.982142857 (Unbiased variance)
	[SHIFT] [$\bar{x}$] [−] [−] 55 [=]	1.625 ($55-\bar{x}$)
	54 [=]	0.625 ($54-\bar{x}$)
	51 [=]	-2.375 ($51-\bar{x}$)
	⋮	⋮

What is $\bar{x}$ and $x\sigma_{n-1}$ for the following table?

Class Number	Value	Frequency
1	110	10
2	130	31
3	150	24
4	170	2
5	190	3
Total		70

SHIFT SAC 110 × 10 $x_{\square}$	110.
130 × 31 $x_{\square}$	130.
150 × 24 $x_{\square}$	150.
170 $x_{\square}$ $x_{\square}$	170.
190 $x_{\square}$ $x_{\square}$ $x_{\square}$	190.
MR 0 9	70.
SHIFT $\frac{\bar{x}}{\square}$	137.7142857
SHIFT $\frac{\sigma_{n-1}}{9}$	18.42898069

***Erroneous data clear/correction I (Correct data operation: 51 $x_{\square}$)**

① If 50 $x_{\square}$ is entered, press SHIFT DEL and enter the correct data.
② If 49 $x_{\square}$ was entered previously, press 49 SHIFT DEL and enter the correct data.
③ If 51 × is entered, press 1 $x_{\square}$ or AC and enter the correct data.

***Erroneous data clear/correction II (Correct data operation: 130 × 31 $x_{\square}$)**

① If 120 × is entered, press AC and enter the correct data.
② If 120 × 31 is entered, press AC and enter the correct data.
③ If 120 × 30 $x_{\square}$ is entered, press 120 × 30 SHIFT DEL and enter the correct data.
④ If 120 × 30 $x_{\square}$ was entered previously, press 120 × 30 SHIFT DEL and enter the correct data.

Manual Alpha Mode

The Alpha mode is generally used when creating programs, and will be described in details later on in this manual. It can also be used for manual calculations to confirm operations, as described below

- Press ALPHA key in the RUN mode to enter the Alpha (character input) mode ("ALPHA" indicator appears on the display).
- The Alpha mode differs from the normal mode (when "ALPHA" is not displayed in the RUN mode). While the Normal mode can be used to perform general calculations, the Alpha mode is a display mode only. The Alpha mode is used to display remarks and the unit of measurement for results obtained by AR, #, and other commands.
- All keys except MODE, BST, FST, SHIFT, 2ndF, C, AC and EXE keys become character or symbol input keys in the Alpha mode. Characters and symbols are marked in red on the panel surface.
- Characters and symbols displayed in the Alpha mode are called "text".
- Text is shown on the upper display screen.

■Key Operations in the Alpha Mode

CAPS : Press to use function commands and functions marked on the key panel in light green. Press 2ndF and "F" appears on the display. Press 2ndF again and the "F" disappears from the display.
Press this key in the Alpha mode and "CAPS" appears on the display indicating that the alphabetic character mode has switched from lowercase to all caps. (The unit is set to lowercase characters after ALL RESET or AC key operation.)

P0 through M+ (Exclusive of MODE, BST, FST SHIFT and 2ndF) :
Pressing of these keys will result in display of the alphabet in the lower case: pressing them after keying in α-S will cause display of alphabet in the upper case.

1 through 9, 0, ·, +, −, ×, ÷ :
Pressing of these keys will result in display of numbers or symbols.
Pressing them after keying in α-S will result in the display of key signs shown below the respective keys.

EXP : Pressing of this key will show exponent sign "E" in the display.
Pressing it after keying in α-S will show the symbol "π".

= : Pressing of this key will show the "=" sign.

[α-S] [EXE SPACE] :
Pressing of this key will generate one space in the display.

[MODE] [1], [MODE] [2], [MODE] [3], [MODE] [×] and [MODE] [÷] :
Pressing of these keys will put the calculator in the "RUN", "WRT", "PCL" and "I/O" modes. (Changing of unit of angle, execution of [MODE] [•] [•] etc. are not possible.)

[EXE], [BST] and [FST] :
Same function as in the NORMAL mode.

[ALPHA] : Clears ALPHA mode.

[M−] [;] : Command for continuing displayed data. The alphabetical character following the " ; " will be linked to alphabetical character immediately before it.

[M+] [AR] : Memory substitution command. Will substitute contents of specified memory into the character data and display it as alphabetical character data.

[α-S] [=] [#] :
Display substitution command. Will substitute displayed number(s) into the alphabetical character data, and display it as alphabetical character data.

[C] : Clears displayed data. (Will not clear the ALPHA mode.)

[AC] : Clears both the display and the ALPHA mode.

■ Examples for Using " ; ", "#" and "AR"

•For displaying "ABC" and "abc" in succession (with calculations being performed intermediately).

[AC] [ALPHA] [a] [b] [c] [ALPHA] 3 [×] 201 [=] [Min] [EXP F] [AC]
[ALPHA] [M−] [;] [CAPS] [A] [B] [C] [ALPHA]

```
abcABC
                0.
```

•When having result of "23 × 5" being displayed with assigning of unit "x = □ □ □ km".

[AC] 23 [×] 5 [=] [ALPHA] [CAPS] [X] [=] [α-S] [#] [k] [m] [ALPHA]

```
x=115km
              115.
```

•When having contents of MF-register (already inputted in first example above) being displayed as "FX-□ □ □P".

[AC] [ALPHA] [CAPS] [F] [X] [−] [M+] [AR] [EXP F] [P] [ALPHA]

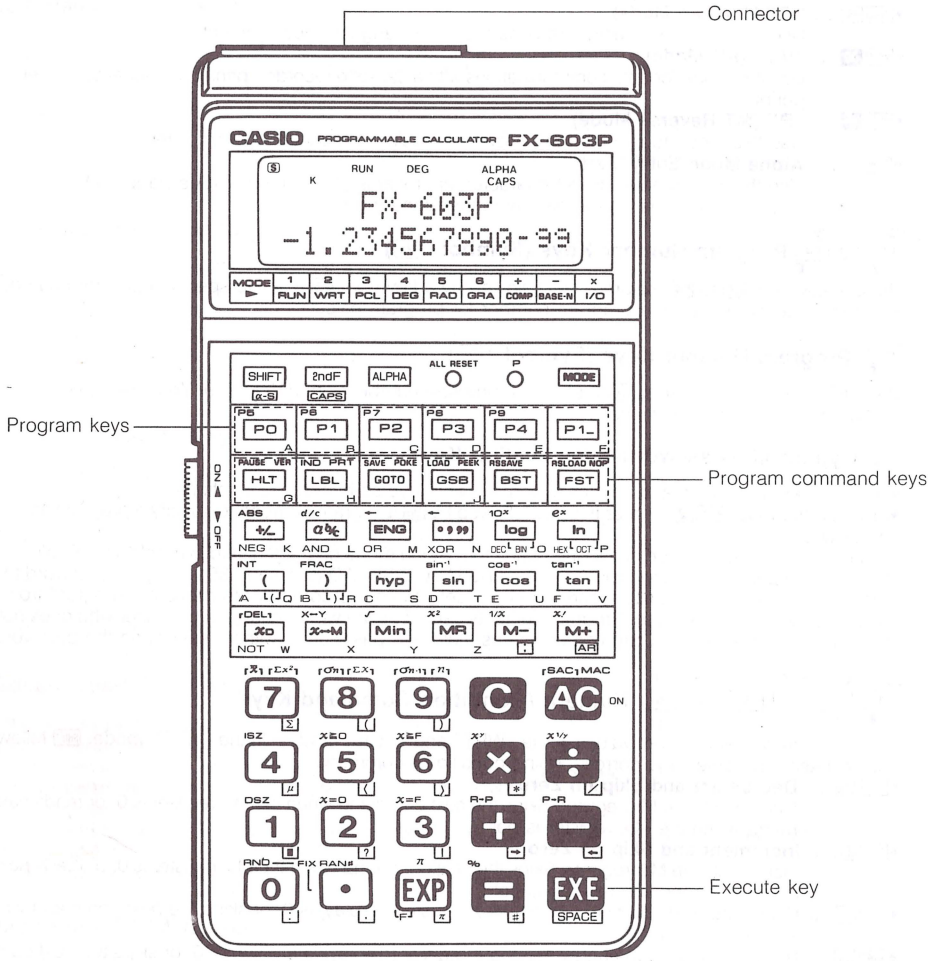
```
FX-603P
                0.
```

Section 2 Program Calculations

This section focuses on programming. Spend a little time mastering the techniques described here and your calculations will become more logical and efficient.

Required Terms for Program Calculations

*See pages 13 through 18 and 35 through 36 for an explanation of keys required for manual calculations.



■Key Functions

[MODE] Mode keys

- [MODE] [1] ... **"RUN" (RUN Mode)**
  Use this mode to perform program execution and manual calculations.
- [MODE] [2] ... **"WRT" (Write Mode)**
  Use this mode to write programs into the calculator and for checking, additions, deletions, and editing.
- [MODE] [3] ... **"PCL" (Program Clear Mode)**
  Use this mode to clear a specific program or all programs.
- [MODE] [4] ... **"DEG" (Degree Mode)**
  Use this mode to specify degrees as the unit of angular measurement.
- [MODE] [5] ... **"RAD" (Radian Mode)**
  Use this mode to specify radians as the unit of angular measurement.
- [MODE] [6] ... **"GRA" (Grad Mode)**
  Use this mode to specify grads as the unit of angular measurement.
- [MODE] [×] ... **"I/O" (I/O Mode)**
  Use this mode for data communications with a cassette recorder, printer, personal computer or other peripheral.
- [MODE] [÷] ... **"R" (MT Reverse Mode)**
  Use this mode to reverse the phase when using a cassette tape recorder.
- [ALPHA] ..... **Alpha Mode Entry/Exit**
  Use this key to enter or exit character input status (Alpha mode). (See page 35.)
  "ALPHA" appears on the display in the Alpha mode.

P5 [P0] A to P9 [P4] E Program Number Keys (Symbol = [Pn])

Press a key from [P0] to [P4], or press [SHIFT] followed by a key from [P5] to [P9] to specify a program number from P5 to P9. You must specify a program number for program calculations.

[P1_] F Program Number Keys (Symbol = [Pn])

Press [P1_] and a key from [0] to [9] to specify a program number from P10 to P19. You must specify a program number for program calculations.

[hyp] Hyperbolic/Password Specification Key

- Use this key as a command key for hyperbolic and inverse hyperbolic functions.
- In the Write mode ([MODE] [2]), press this key followed by [Pn] (program number) to specify a program as including a password.

*A password is a secret code consisting of any four Alpha mode characters and symbols. Use English characters only to specify the password when using RSSAVE/RSLOAD (see page 85). Assign a password to a program when you do not want anyone to have access to your program, or to prevent a program from being altered or accidentally erased. Program contents cannot be viewed or changed by a user who does not know the password. Calculations can use programs that have passwords, without specifying the password.

DSZ [1] ■ ISZ [4] μ x=0 [2] ? x≥0 [5] < x=F [3] ! x≥F [6] > Numeric/Condition Command Keys

Use the numeric keys to input values in the "WRT" and "RUN" modes. In the "WRT" mode. [SHIFT] followed by one of these keys enters the corresponding conditional command.

- [SHIFT] [DSZ] ... **Decrement and Skip on Zero**
  Decrements the M00 register. Skips the next command when the M00 register is 0, or reads next command when the M00 register is not 0.
- [SHIFT] [ISZ] ... **Increment and Skip on Zero**
  Increments the M00 register. Skips the next command when the M00 register is 0, or reads next command when the M00 register is not 0.
- [SHIFT] [x=0] ... Reads the next command when the X register (display) is 0, or skips the next command when the X register is not 0.
- [SHIFT] [x≥0] ... Reads the next command when the X register (display) is positive or 0, or skips the next command when the X register is negative.
- [SHIFT] [x=F] ... Reads the next command when the values of the X register and MF register are equal, or skips the next command when those values are different.
- [SHIFT] [x≥F] ... Reads the next command when the value of the X register is greater than or equal to the value of the MF register, or skips the next command when the value of the X register is less than the value in the MF register.

SAC MAC
AC ON **All Clear/Standard Deviation Calculation All Clear/Memory All Clear Key**

- Press this key to clear all registers except the M*n* register. Press to cancel program calculation during execution (indicator on display).
- In the WRT mode, press this key to clear everything except the M*n* register.
- In the PCL mode, press this key to delete the specified program only.

C Clear Key

- Press this key to clear the display.
- In the WRT mode, press this key to clear display of a program's command step. "C", itself, cannot be used in a program.

PAUSE VER
HLT G **Halt/Pause/Verify Key**

- Press this key during program execution to halt the program.
- In the WRT mode, press this key to stop program execution to input data or display results. When this command is encountered, "HLT" is displayed and program execution is stopped.
- Following SHIFT, press this key to temporarily stop program execution. When this command is encountered, program execution is stopped for approximately one second and then resumed automatically.
- In the RUN mode or I/O mode, 2ndF followed by this key checks program and memory contents recorded on cassette tape.

IND PRT
LBL H **Label/Indirect/Print Key**

- In the WRT mode, press this key to write the jump destination number for an unconditional jump.
- Following SHIFT, press this key to specify the indirect address of a memory and the indirect destination number for a manual jump.
- In the WRT mode, press this key following SHIFT to specify the memory, unconditional jump and indirect address of the subroutine.
- Press 2ndF followed by this key in the RUN mode or I/O mode to print the program, memory contents or display.

SAVE POKE
GOTO I **Goto/Save/Poke Key**

- Press this key to perform a manual jump while program execution is stopped by a "HLT" command .
- In the WRT mode, press this key to write an unconditional jump command.
- While connected to an FA-6, press this key following SHIFT to record the contents of the M*n* register to cassette tape.
- In the WRT mode, press this key following SHIFT to write a command to record the contents of the M*n* register to cassette tape.
- Following SHIFT, press this key in the I/O mode while connected to a FA-6 to record a program stored in memory to cassette tape.
- In the WRT mode, 2ndF followed by this key writes data to the specified address.

LOAD PEEK
GSB J **Gosub/Load/Peek Key**

- Press this key to perform program debug (see page 50).
- In the WRT mode, press this key to write a subroutine call command.
- While connected to an FA-6, press this key following SHIFT to return data from a cassette tape to the M*n* register.
- In the WRT mode, press this key following SHIFT to write a command to recall data recorded on a cassette tape to the M*n* register.
- While connected to a FA-6, press this key following SHIFT in the I/O mode to recall program contents recorded on cassette tape.
- Press 2ndF followed by this key in the RUN mode to call memory contents specified by an address.

RSSAVE
BST **Back Step/RSSAVE Key**

- Press this key during debug to see the program command that was executed. The execution command is displayed while the key is pressed.
- Press this key to return to the previous step in a program being written or checked in the WRT mode. Press and hold down the key to back step at high speed.
- In the RUN or I/O mode, press this key following SHIFT to send the contents of memory and programs to a personal computer or another FX-603P through an RS-232C terminal.

RSLOAD NOP

[FST] Forward Step/RSLOAD/NOP Key

- Press this key during debug to execute the program step-by-step.
- Press this key in the WRT mode when checking the program to advance to the next step of the program. Press and hold down the key to forward step at high speed.
- In the RUN or I/O mode, press this key following [SHIFT] to receive the memory contents and programs from a personal computer or another FX-603P, via the RS-232C port.
- In the WRT mode, [2ndF] followed by this key writes an NOP command into the program. This command advances the program one step only and has no effect on the program. Use the NOP command as a dummy command to ignore a skip after writing an ISZ or DSZ, or to debug a program.

[EXE] Execute Key

- Press this key to restart the program while "HLT" is displayed, indicating a halt in program execution.
- In the WRT mode, press this key to write a command to establish a link with the FA-6 linkage for programmed input or output of data from a cassette tape.

Connector

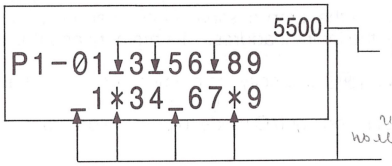
- For connection with the FA-6 Interface Unit.

■Program Steps and Command Display

- This unit has a range of 6,144 steps and a maximum of 20 programs (P0 to P19) can be stored in memory.
- The number of the program being used and the number of remaining steps can be confirmed as follows.

[MODE] [2], [MODE] [3]

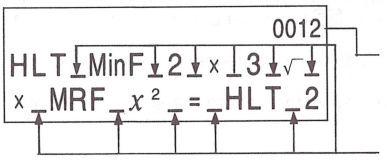
or [MODE] [×]



Number of remaining steps

Used program number (asterisk indicates program with password)

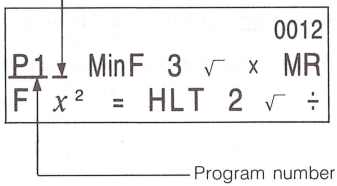
- During writing or checking of a program, commands that have been written are shown on the display. The number of the command located at the lower right of the display is shown in the upper right.



Step number of "2" at far right of lower display

One space between steps

- During debugging (see page 50), the current program number is shown to the left of the upper display. The program number is separated from the commands in the program by a space.



•Basically, each function requires a single step, but there are some commands where a single function requires multiple steps.

•**One function/one step**
Numbers (0 to 9), (,), +/−, calculation keys (+, −, ×, ÷), ( ), scientific functions (sin, cos, log, etc.), letters, " . ", HLT, PAUSE, NOP, RND, EXE, SEXE, P0 to P9, M00 to M19, MF, MIF, etc.

•**One function/two steps**
Fractions, FIX, BASE-N commands, VER, PRT, RSSAVE, RSLOAD, FEXE, P10 to P19, GSB10 to GSB19, memories above M20

•**One function/six steps**
PEEK and POKE (2 steps + 4 steps for 4-digit address)

Steps are also required to specify a program number and enter a password.
•Program number P0 to P9: 1 step
•Program number P10 to P19: 2 steps
•Password entry (per program): 5 steps
Example: Program number 12, which has a password, uses 7 steps (2 steps + 5 steps).

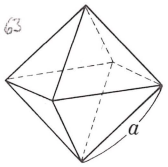
What Is A Program?

•The following outlines the fundamental steps for creating a program.

(1) Preparation
Consider the problem and determine the formula.
(2) Programming
Incorporate the formula into a program.
(3) Program Input
Store the finished program in the calculator.
(4) Program Execution
Execute the program to perform the calculation.

The following examples illustrate this procedure.

Example: Find the surface area and volume of a regular octahedron when the length of one side is given.



Length of one side (a)	Surface area (S)	Volume (V)
10cm	( )cm^2	( )cm^3
7	( )	( )
15	( )	( )

(1) Formulas

For surface area S, volume V, and one side a, the formulas for calculating S and V of a regular octahedron are:

$$S = 2\sqrt{3}\,a^2 \qquad V = \frac{\sqrt{2}}{3}a^3$$

(2) Programming

The key operation to manually calculate the above formula is:

2 × 3 SHIFT √ × Numeric value a SHIFT x^2 = → S
2 SHIFT √ ÷ 3 × Numeric value a SHIFT x^3 3 = → V

In the above example, numeric value a is used twice, so it makes sense to store it in memory F before the calculations.

Numeric value a Min EXP F 2 × 3 SHIFT √ × MR EXP F SHIFT x^2 = → S
2 SHIFT √ ÷ 3 × MR EXP F SHIFT x^3 3 = → V

With this unit, the operations performed for manual calculations can be used as they are in a program. Once program execution starts, it will continue without stopping. You must use the "HLT" command to stop the program to input data and to display results.

To store the previous program in P0:

P0 HLT, Min F, 2, ×, 3, SHIFT √, ×, MR F, SHIFT x^2, =, HLT, 2, SHIFT √, ÷, 3, ×,

↑ Program number required

↑ To input data

↑ To see the result

MR F, SHIFT x^y, 3, =, HLT, (21 steps)

↑ To see the result

*Commas have been inserted between steps in this manual and the supplemental program library for easier understanding.

(3) Program Input

To store a program in the calculator...

(1) Enter MODE 2 to select the WRT mode.
If a program is already stored under the number you want to use to store a program, you must change the number or delete the previous program. (See Erasing Programs, and Changing Program numbers, page 53.)

(2) Press the keys to enter commands as they appear sequentially in the program. Press C and re-enter the correct data if you make a mistake.

Operation	Display
MODE 2	WRT 6144 P1-0123456789 P 0123456789
P0	WRT (Omitted below) 6143 P0
HLT	0001 HLT
Min EXP F	0002 HLT MinF
2	0003 HLT MinF 2
×	0004 HLT MinF 2 ×

3	0005 HLT MinF 2 × 3
SHIFT √	0006 HLT MinF 2 × 3 √
×	0007 HLT MinF 2 × 3 √ ×
MR EXP F	0008 HLT MinF 2 × 3 √ × MRF
SHIFT x^2	0009 HLT MinF 2 × 3 √ × MRF x^2
=	0010 HLT MinF 2 × 3 √ × MRF x^2 =
HLT	0011 HLT MinF 2 × 3 √ × MRF x^2 = HLT
2	0012 HLT MinF 2 × 3 √ × MRF x^2 = HLT 2
SHIFT √	0013 T MinF 2 × 3 √ × MRF x^2 = HLT 2 √
÷	0014 MinF 2 × 3 √ × MRF x^2 = HLT 2 √ ÷
3	0015 F 2 × 3 √ × MRF x^2 = HLT 2 √ ÷ 3
×	0016 2 × 3 √ × MRF x^2 = HLT 2 √ ÷ 3 ×

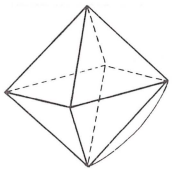
Operation	Display
MR EXP F	0017 3 √ x MRF x^2 = H LT 2 √ ÷ 3 x MRF
SHIFT x^y	0018 x MRF x^2 = HLT 2 √ ÷ 3 x MRF x^y
3	0019 MRF x^2 = HLT 2 √ ÷ 3 x MRF x^y 3
=	0020 RF x^2 = HLT 2 √ ÷ 3 x MRF x^y 3 =
HLT	0021 2 = HLT 2 √ ÷ 3 x MRF x^y 3 = HLT
MODE 1	RUN 0.

*In the WRT mode, each press of a key stores the command assigned to that key into the program memory as part of a program. The command stored into memory as well as the number of steps used up to that point are shown on the display. Also note that program execution stops automatically when the end of the program is reached, so a HLT command at the end of the program is not necessary.

(4) Program Execution

To use the stored program and perform calculations:
(1) Enter MODE 1 to select the RUN mode.
(2) Specify the program number (P0 to P4, SHIFT P5 to SHIFT P9, P1 0 to P1 9).
(3) If the program is stopped by a "HLT" command, input data (or read the result) and press EXE.
(4) Respecify the program number if you want to repeat the calculation.
(5) Press MODE 1 to stop program execution or clear "HLT".

The surface (S) and volume (V) for the regular octahedron in the sample problem are calculated as:



Length of one side (a)	Surface area (S)	Volume (V)
10cm	(346.4101615)cm^2	(471.4045208)cm^3
7	(169.7409791)	(161.6917506)
15	(779.4228634)	(1590.990258)

Operation	Display	
MODE 1	RUN 0.	(Not required if already in the "RUN" mode.)
(Program number specification) PO	HLT RUN (Omitted below) 0.	
10 EXE	346.4101615	(S when $a=10$)
(Continuing) EXE	471.4045208	(V when $a=10$)
(To repeat the calculation) PO	471.4045208	
(a) 7 EXE	169.7409791	(S when $a=7$)
(Continuing) EXE	161.6917506	(V when $a=7$)
PO	161.6917506	
(a) 15 EXE	779.4228634	(S when $a=15$)

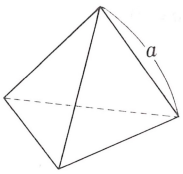
Operation	Display
[EXE]	1590.990258 (V when $a=15$)
(Ends program calculation) [MODE] [1]	RUN 0.

"HLT" disappears

* If execution is halted by HLT, enter data or read the result and then press [EXE].

Program Checking and Editing (Correction, Addition, Deletion)

Example:
Find the surface area and volume of a regular tetrahedron when the length of one side is given.



Length of one side (a)	Surface area (S)	Volume (V)
10cm	(173.2050808)cm^2	(117.8511302)cm^3
7.5	(97.42785793)	(49.71844555)
20	(692.820323)	(942.8090416)

(1) Formulas

For surface area S, volume V, and one side a, the formulas that calculate S and V for a regular tetrahedron are:

$$S=\sqrt{3}\,a^2 \qquad V=\frac{\sqrt{2}}{12}a^3$$

(2) Programming

The following procedure stores numeric value a in memory F and assigns to program number P1.

P1 HLT , Min F , 3 , SHIFT $\sqrt{\ }$, × , MR F , SHIFT x^2 , = , HLT , 2 , SHIFT $\sqrt{\ }$, ÷ , 1 , 2 , × , MR F , SHIFT x^y , 3 , = , HLT , (20 steps)

This program may be entered into the calculator anew. However, because this program is similar to the program for a regular octahedron on page 41, it is easier to edit our original program.

(3) Program Check and Edit

Select the WRT mode, specify the program number, and press [FST] or [BST] to display the number of steps and program contents. Display the step you want to change in the previously input program.
First, compare both the octahedron program and the tetrahedron program.
1. Change the program number from P0 to P1.
2. Delete "2, ×".
3. Change the "3" of "÷, 3, ×," to "1, 2,".

Operation	Display	
MODE 2	WRT 6122 P1-0123456789 P _123456789	
(Call program P0.) P0	WRT (Omitted below) 6122 P0	
C Change program number	6122 P	
P1	6122 P1	(Moves program P0 to program P1; may be omitted if you do not want to maintain contents of program P0.)
(Program check) FST	0001 HLT	
(Program check Abbreviated below) FST	0002 HLT MinF	
FST	0003 HLT MinF 2	
(Delete "2".) C	0002 HLT MinF	(Moves to previous command when "2" disappears.)
FST	0003 HLT MinF x	
(Delete "x".) C	0002 HLT MinF	
FST	0003 HLT MinF 3	

Operation		Display
	FST	0004 HLT MinF 3 √

Press FST to advance to "2 √ ÷ ".

	FST	0012 HLT MinF 3 √ x MR F x^2 = HLT 2 √ ÷	(Can also hold down FST. If you go too far, press BST to return.)
	FST	0013 T MinF 3 √ x MRF x^2 = HLT 2 √ ÷ 3	
(Delete "3".)	C	0012 HLT MinF 3 √ x MR F x^2 = HLT 2 √ ÷	
(Addition)	1	0013 T MinF 3 √ x MRF x^2 = HLT 2 √ ÷ 1	
(Addition)	2	0014 MinF 3 √ x MRF x ^{2} = HLT 2 √ ÷ 12	
	FST	0015 inF 3 √ x MRF x^2 = HLT 2 √ ÷ 12 x	

Press FST to advance to "3 = HLT".

	FST	0020 = HLT 2 √ ÷ 12 x MRF x^y 3 = HLT	(HLT is 20th step.)
(Look at beginning of program.)	FST	6122 P1	(Return to beginning; number of remaining steps display)
(Look at beginning of program.)	FST	0001 HLT	

(Look at beginning of program.) FST	0002 HLT MinF	
(Back up one step.) BST	0001 HLT	
(Back up one step.) BST	6122 P1	(Return to beginning; number of remaining steps display)
(Back up one step.) BST	0020 = HLT 2 √ ÷ 12 x MRF x^y 3 = HLT	(Program check from program end)
(Back up one step.) BST	0019 F x^2 = HLT 2 √ ÷ 12 x MRF x^y 3 =	
MODE 1	RUN 0.	

Summary of Program Check

(1) Press MODE 2 to enter the WRT mode.
(2) Enter the number of the program you want to check.
(3) Press FST or BST to display a command.
Hold down FST/BST to scroll through the program.

Note: See page 65 for checks of programs with passwords.

Summary of Program Editing

(1) Use program check to display the step to be edited.
(2) For deletions, display the step you want to delete and press C.
(3) For modifications, display the step you want to change, delete with C, and enter the correct data.
(4) For additions, display the step immediately preceding the addition and then enter the additional step. Additions which cause the maximum number of steps to be exceeded cannot be saved.

*Additions and deletions may be performed in any order. Performing additions and deletions automatically changes the number of steps in the program.

(4) Program Execution

Operation	Display	
MODE 1	RUN 0.	(Not required if already in "RUN" mode.)
(Program number specification) P1	HLT RUN (Omitted below) 0.	
10 EXE	173.2050808	(S when $a = 10$)
EXE	117.8511302	(V when $a = 10$)

P1 repeated below

отладка программ

Program Debugging

Program debugging is accomplished by entering simple data for program execution and executing the program **one step at a time** Program errors are detected by checking the program at each step.

Summary of Debugging

(1) Press MODE 1 to enter the RUN mode.
(2) Press GSB and enter the number of the program you want to debug.
(3) Each press of FST executes one step of the program. Input data and press FST when "HLT" appears on the display.
(4) Press and hold down BST to display the program command that was executed and the number of steps.
(5) Perform (3) and (4) as required to check the program.
*(3) and (4) can be performed even during normal program execution (from the position the program was stopped by HLT). EXE can be pressed during debugging to resume normal program execution.

Note: See page 65 for debugging of programs with passwords.

Example: Debugging the previous program.

Operation	Display	
MODE 1	RUN 0.	(Not required if already in "RUN" mode.)
(Debug start) GSB P1	RUN (Omitted below) P1	

Старт отладочной программы

	FST	HLT 0.	(HLT is 1st step.)
(Data) 2	2	HLT 2.	(Input simple data.)
	FST	2.	(Min F is 2nd step.)
	FST	3.	(Value "3" is 3rd step.)
	FST	1.732050808	($\sqrt{}$ is 4th step.)
(Press and hold down to check command.)	BST	0004 P1 HLT MinF 3 $\sqrt{}$	
	FST	1.732050808	($\times$ is 5th step.)
	FST	2.	(MRF is 6th step.)
	FST	4.	(x^2 is 7th step.)
	FST	6.92820323	(= is 8th step.)
	FST	HLT 6.92820323	(HLT is 9th step.) S when $a=2$
	FST	2.	(Value "2" is 10th step.)

FST		(√ is 11th step.)
	1.414213562	
FST		(÷ is 12th step.)
	1.414213562	
(Press and hold down to check command.) BST	0012 P1 MinF 3 √ x MR F x^2 = HLT 2 √ ÷	
FST		(Value "1" is 13th step.)
	1.	
FST		(Value "2" is 14th step.)
	12.	
FST		(× is 15th step.)
	0.11785113	
(Press and hold down to check command.) BST	0015 P1 3 √ x MRF x^2 = HLT 2 √ ÷ 12 x	
FST		(MRF is 16th step.)
	2.	
(Press and hold down to check command.) BST	0016 P1 x MRF x^2 = HL T 2 √ ÷ 12 x MRF	
FST		(x^y is 17th step.)
	2.	
(Press and hold down to check command.) BST	0017 P1 RF x^2 = HLT 2 √ ÷ 12 x MRF x^y	
EXE	HLT 0.942809041	V when $a=2$

Erasing Programs

•Erasing All Programs

Enter the PCL mode ([MODE] [3]) and then press [2ndF] [MAC].

Note: Programs with passwords will also be deleted.

Values in independent memories (M*n* register) will not be erased. Clear the M*n* register using [2ndF] [MAC] in the RUN mode.

•Erasing a Single Program

Enter the PCL mode and specify the program number ([Pn] [AC]).

Note: See page 66 for the procedure to delete programs with passwords.

Changing Program Numbers

A program number from P0 to P19 is required at the beginning of all programs, and the same program number cannot be used for two different programs. If P0 is already used by a program and you want to store another program under P0, change the program number of the program in memory to make P0 available for the new program.

To Change a Program Number

(1) Press [MODE] [2] to enter the WRT mode and then specify the current program number for the program you want to renumber.

(2) Press [C].

(3) Specify the new program number.
If the number specified is already being used for storage of a program, you won't be able to store the program. Use a number that is currently available.

(4) Enter the RUN mode ([MODE] [1]) or the WRT mode ([MODE] [2]).

Example 1: Change program number P0 to program number P9.
[MODE] [2] [P0] [C] [SHIFT] [P9] [MODE] [1]

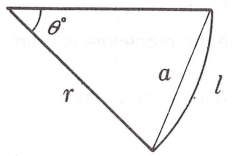
Example 2: Move program number P5 to program number P6.
[MODE] [2] [SHIFT] [P5] [C] [SHIFT] [P6] [MODE] [1]

Note: See page 66 for details on handling programs with passwords.

Constructing Programs

In this section, a number of possible methods for solving a particular problem are given, along with their relative strengths and weaknesses.

Example:



Calculate the length of arc (l) and the length of chord a for a sector with a central angle of θ ° and radius (r).

$$l = \frac{r\pi\theta}{180} \qquad a = 2r\sin\frac{\theta}{2}$$

•Procedures

	Procedures	Program
A	Sequence 1 [PO] 2 r [EXE] 3 θ [EXE] $\rightarrow l$ 4 [EXE] $\rightarrow a$	PO MODE 4, HLT, Min 01, ×, HLT, Min 02, ×, SHIFT π, ÷, 1, 8, 0, =, HLT, MR 02, ÷, 2, =, sin, ×, 2, ×, MR 01, =, (PO) 24 steps+1 step
B	Sequence 1 r [PO] 2 θ [EXE] $\rightarrow l$ 3 [EXE] $\rightarrow a$	PO MODE 4, Min 01, ×, HLT, Min 02, ×, SHIFT π, ÷, 1, 8, 0, =, HLT, MR 02, ÷, 2, =, sin, ×, 2, ×, MR 01, =, (PO) 23 steps+1 step
C	Sequence 1 r [Min] [0] [1] 2 θ [Min] [0] [2] 3 [PO] $\rightarrow l$ 4 [EXE] $\rightarrow a$	PO MODE 4, MR 01, ×, SHIFT π, ×, MR 02, ÷, 1, 8, 0, =, HLT, MR 02, ÷, 2, =, sin, ×, 2, ×, MR 01, =, (PO) 22 steps+1 step
D	Sequence 1 r [PO] 2 θ [P1] 3 [P2] $\rightarrow l$ 4 [P3] $\rightarrow a$	PO Min 01, 1 step P1 Min 02, MODE 4, 2 steps P2 MR 01, ×, SHIFT π, ×, MR 02, ÷, 1, 8, 0, =, 10 steps P3 MR 02, ÷, 2, =, sin, ×, 2, ×, MR 01, 10 steps (PO P1 P2 P3) =, Total 23 steps+4 steps

•Strengths and Weaknesses of Programs

Program A (Standard Program)

- After the program number is specified, standardization using a data [EXE] or [EXE] operation makes the program easy to understand.
- Many other programs can be incorporated into this program (maximum of 20).
- Small number of steps.
- Partial changes of data or viewing of partial results is impossible because the procedure is fixed.

Program B (Variation of Program A)

- Standardization is not as good as in program A. Other aspects are the same as program A.

Program C (complicated data input)

- Program C has the smallest number of steps.
- Many other programs can be incorporated into this program.
- Data must be input to many memories before the program can be executed. Data input is troublesome and prone to mistakes.

Program D (user function format)

- Data input can be performed at any point in the program because [Pn] has many functions. This is also true for viewing of results.

- Partial changes of data and viewing of subsequent results are extremely easy.
- Program D has the greatest number of steps.
- [Pn] is insufficient for programs that have a lot of input data and calculation results. [SHIFT] [P1] must be used when there are six or more program numbers.
- Program D is not suitable for handling multiple programs.

The various strengths and weakness of the different types of programs make it impossible to state which type is the best.
Type A is used for general explanations in this manual and the supplemental library, while type D or other types are used for calculations.

Programming and Operation Rules

■ Formulas

- Formulas can be incorporated into programs as they are performed manually (true algebraic logic).
- Programmed functions can be incorporated into programs.
- There is no limit to the length of a formula.
- Any number of constants can be included in one formula. Mantissas are limited to ten digits and exponents are limited to two digits. One digit is one step (decimal point, +/−, and exponent are also one step each).
- Constant calculations (+ +, × ×, $x^y x^y$, etc.) can be incorporated into programs and execution is the same as manual calculation.

■ During Program Write ("WRT" displayed)

- The keys that are operational immediately after entry into the WRT mode are [P0] to [P4], [SHIFT] [P5] to [SHIFT] [P9], [P1] [P0] to [P1] [P9], [MODE] [3], [MODE] [×] and [hyp] (for programs with passwords).
- The step number displayed when "WRT" appears on the display is the write step number, except for [Pn] at the beginning of the program. The P*n* is also written into program memory. This uses one or two steps. For programs with passwords, six or seven steps are used.
- If the write step disappears during program write, further writing is impossible, but previously entered data is not erased.
- The function input range and parentheses level overflow are not checked during "WRT", but these errors can be generated during program execution.
- Press [P0] to [P4], [SHIFT] [P5] to [SHIFT] [P9], [P1] [0] to [P1] [P9] (P*n* specification), [MODE] [1] to [MODE] [3] or [MODE] [×] in "WRT" to finish program writing. You may then write to a new program number or switch to a different mode.
- The last HLT in the program is not necessary. If there is no HLT, the last command is executed and the program ends as displayed.

■ During Program Execution ("RUN" displayed)

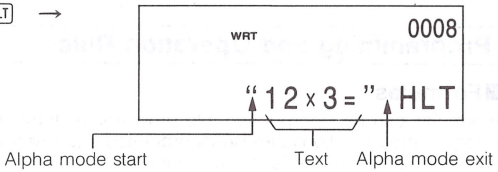
- If a [Pn] key is pressed for a program that does not exist in memory, no action is taken.
- Manual calculation (interrupt calculation) can be performed before or during the start of program execution when the program is stopped. Manual calculation results can be input as data and display results can be used in calculations. However, when the program is stopped during execution of a formula or when a displayed value is to be used in a subsequent calculation, you must perform the interrupt calculation and return to the previous status before re-starting the program.
- Press [AC] when the program is stopped to retain the program steps, and to clear displayed values and calculation commands. Press [AC] during execution (when only symbols are shown on the display) to terminate program execution. Use this feature to terminate programs that have extremely long program calculations or endless loops.
- Press [HLT] during program execution (when only symbols are shown on the display) to suspend program execution at the step that was being executed. This is the same as pressing [HLT] during a pause. Use this procedure to debug programs during execution.
- The following conditions cause errors ("Error" displayed) during program execution:
  (1) A calculation result or memory contents with too many digits.
  (2) A function or a result in excess of the input range.
  (3) A non-existent jump destination specified by [GOTO].
  (4) A non-existent subroutine specified by [GSB]. ((3) and (4) produce "Go Error" display.)
  (5) Overflow of L*n* register for parentheses and calculations during execution. (This produces a "( ) Error" display.)

All of the above stop program execution, and display the "Error" message along with the program step number that caused the error. Exit the error conditions by pressing [AC] ([C] can also be used in 5) and press [BST] to check the command code that caused the error.
*Programs with passwords cannot be checked.
* When text is used for comments, the display disappears during program execution.

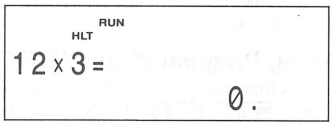
Programs with Remarks Display Using Text

- See the Manual Alpha Mode on page 35 for details concerning text objectives, and key operations during the Alpha mode.
- Press [ALPHA] to enter the Alpha mode in the RUN mode, after [Prn] specification in the WRT mode, or after a save, load or PRT specification in the I/O mode. This permits input of text.
- "ALPHA" is shown on the right of the upper display while the unit is in the Alpha mode.
- Selecting the Alpha mode in the WRT mode displays " ". " " is displayed when Alpha mode is exited, and the characters between " " and " " are all text. Numbers and calculation symbols are displayed as is and calculations are not affected.

Example: [MODE] [2] [P0] [ALPHA] [1] [2] [×] [3] [=] [ALPHA] [HLT] →



(Continuing above operation) [MODE] [1] [P0] →



[ALPHA] operation in this manual and the supplementary library is denoted by "AL for Alpha mode start and AL" for Alpha mode exit.

■ Text Program Execution

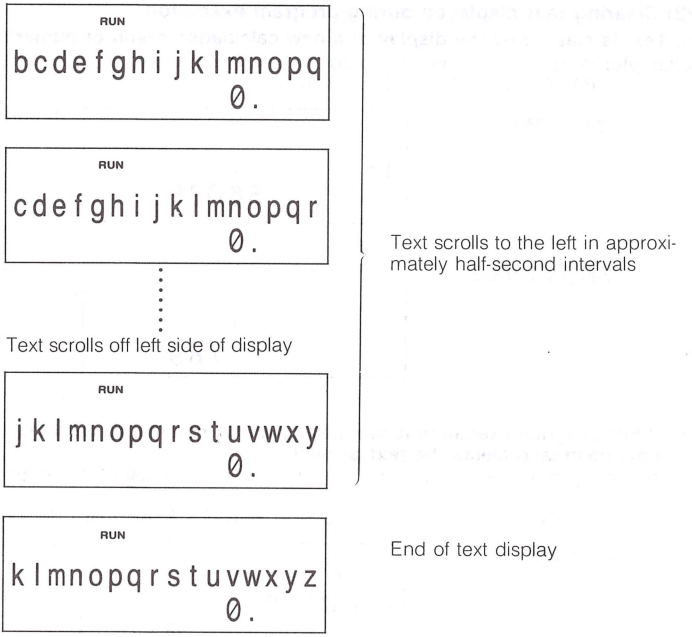
- Write text in a program and execute the program to display text as described below.

1. When there are 16 or fewer characters, all of the characters are displayed as the text program is executed.
2. When there are 17 or more characters, the first 11 characters are displayed for approximately two seconds, and then the characters scroll to the left in approximately half-second intervals until all characters have been shown. The last 16 characters remain on the display at the end of text display.

Example: Write text "AL abcdefghijklmn...xyz AL" to P3.

[MODE] [1] [P3] →

Displayed when there is more text to be displayed (approximately 2 seconds)



Note: Press [HLT] while text is scrolling to the left to suspend movement. Then, each press of [FST] scrolls the text to the left, one character at a time. Press [EXE] to return to character scrolling.

- After text program execution, the program executes the next command and the text display continues and the lower calculation display is also retained.
  Note: Use this function to display contents and the name of a calculation as remarks during long program calculations.
- The lower calculation display is not affected by text program execution, so text and numbers can be handled at the same time without creating a special program.

■ Affect of Text Displays on Subsequent Displays

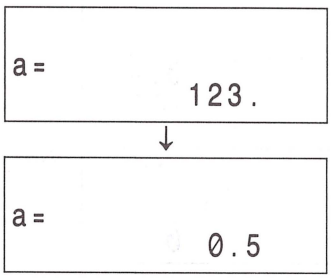
The following examples illustrate the affect of text displays on the displays of subsequent operations.

(1) Text display

Once text is displayed, it remains displayed even if it is followed in the program by numeric input, function execution, or a calculation command.

Example: Program the following in program area P0 and execute.
P0 "AL, a, =, AL", MR01, (, 123,), SHIFT PAUSE, +, 30, sin

[MODE] [1] [P0]



Contents of memory 01 ("123")

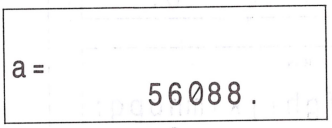
(2) Clearing text displayed during program execution

a. Text is cleared by the display of a new calculation result or numeric input.

Example: Program the following in program area P0 and execute. Then enter the value 789.

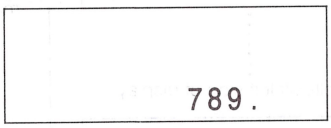
P0 "AL, a, =, AL", 123, ×, 456, =

[MODE] [1] [P0]



(Program result)

789 (Register)



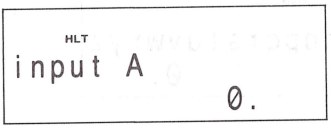
(New entry)

b. While program execution is stopped by a HLT command, pressing the [EXE] key to advance to the next command clears the text display.

Example: Program the following in program area P0 and execute. Press [EXE] following execution of the HLT command.

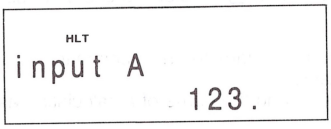
P0 AC, "AL, i, n, p, u. t, α–S SPACE, CAPS A, AL", HLT, Min00

[MODE] [1] [P0]



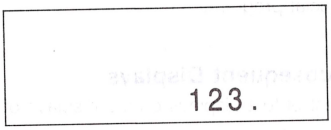
(Prompt for input)

123 (Register)



(Input of 123)

[EXE]



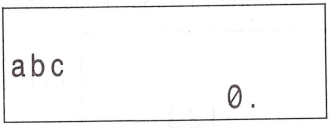
(Execution resumed)

c. Input of new text while text is displayed clears the initially displayed text.

Example: Program the following in program area P0 and execute. Then enter the character "**d**".

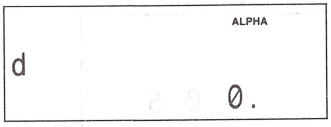
P0 "AL, a, b, c, AL"

[MODE] [1] [P0]



(Program result)

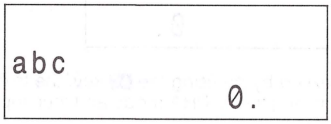
[ALPHA] [d]



(New input)

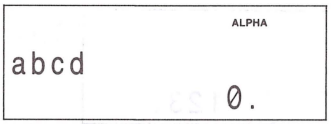
Note: Starting new text input with a semicolon causes the new text to be appended to the end of the existing text.
Example: Program the following in program area P0 and execute. Then enter " **;d**".
P0 "AL, a, b, c, AL"

MODE 1 P0



(Program result)

ALPHA M− d



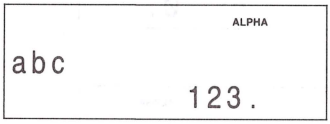
(New input)

(3) Clearing a text display

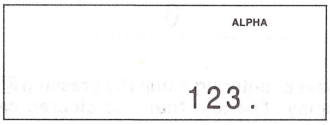
a. Press the C key to clear text from the display at any time while inputting text in the ALPHA mode.
Example: Enter the following. "a b c" 123 " C

ALPHA a b c ALPHA

123 ALPHA



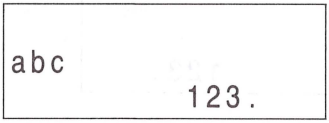
C



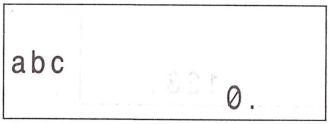
Note: Pressing the C key while the unit is not in the ALPHA mode causes the numeric input only to be cleared.
Example: Enter the following "a b c" 123 C

ALPHA a b c ALPHA

123



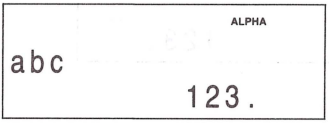
C



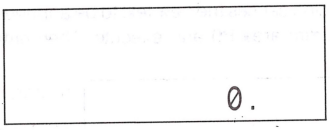
b. Pressing the AC key while inputting text in the ALPHA mode clears the text and exits the ALPHA mode.
Example: Enter the following. "a b c" 123 " AC

ALPHA a b c ALPHA

123 ALPHA



AC

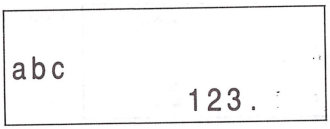


Note: Even though the ALPHA mode is exited by pressing the AC key, the text that was cleared from the display is still retained internally. Re-entering the ALPHA mode and then inputting a semicolon displays the text that was originally cleared.

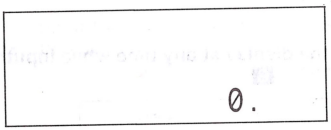
Example: Enter the following. "a b c" 123 AC

ALPHA a b c ALPHA

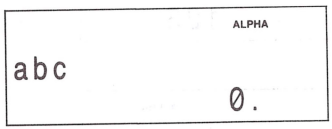
123



AC



ALPHA M−

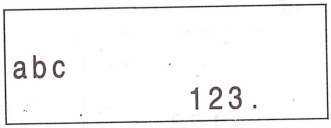


c. While text and numeric input is displayed, entering a null (by pressing ALPHA twice without input) causes the text to be cleared from the display. The text that was cleared can be recalled to the display by inputting a semicolon.

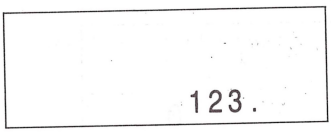
Example: Enter the following. "a b c" 123 AC

ALPHA a b c ALPHA

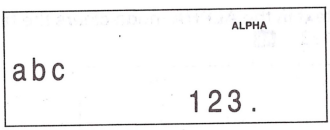
123



ALPHA ALPHA



ALPHA M−



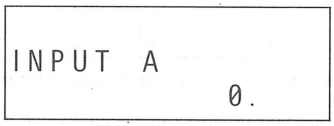
■Using Text in Programs

Note that text operations are described here using example *routines*. Some of these routines can be used alone as a program, but most are meant to be incorporated as part of a larger program. You can make changes in these example routines to suit the needs of your program.

•Text can be used to display messages that prompt for input of desired data.

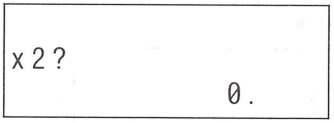
Example 1: [ALPHA][CAPS][I][N][P][U][T][α-S][EXE SPACE][A][ALPHA][HLT][Min]05 .....

This routine results in the display illustrated below. The value input in response to this prompt is stored in memory M05 when [EXE] is pressed.

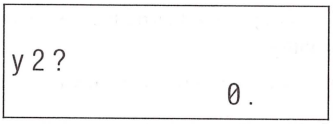


Example 2: [ALPHA][CAPS][X]2[α-S][?][ALPHA][HLT][Min]01[ALPHA][Y]2[α-S][?][ALPHA][HLT][Min]02 .....

This routine produces the following display.



The value input in response to this prompt is stored in memory M01 when [EXE] is pressed, and then the following prompt appears.



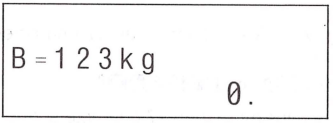
Input here is stored in memory M02 when [EXE] is pressed.

•Text can also be used with results to more clearly indicate the meaning of the values that are shown on the display.

① **The AR command recalls a numeric value from a memory and inserts it into text. Once the value is mixed with the text, it is handled as text itself, and so it cannot be used in further calculations.**

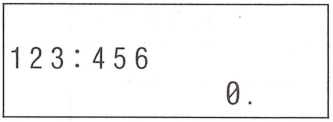
Example 3: [ALPHA][CAPS][B][M+ AR][EXP F][CAPS][K][G][ALPHA][HLT] .....

This routine recalls the contents of the MF register (123), and inserts it between the text "B=" and "kg", producing the following display.



Example 4: [ALPHA][M+ AR]01[α-S][:][M+ AR]02[ALPHA][HLT] ..... (M01: 123 / M02: 456)

This routine recalls the contents of memory M01 (123) and memory M02 (456), and displays them separated by a colon.



*You can use any number of AR commands within text.

② [#] **is used to reserve a digit position within text for the display of a value. Each [#] represents a digit or a position for the decimal point.**

Example 5: [MR] [F] [SHIFT] [RND] [FIX] 3 [ALPHA] [A] [=] [α-S] [#] [α-S] [#] [α-S] [#] [α-S] [#] [α-S] [#] [α-S] [#] [α-S] [#] [ALPHA] [HLT] .....

This routine causes the contents of memory M_F to be rounded off to three decimal places, and then reserves seven positions for display of the value.

```
A = □□□. □□□
        □□□. □□□
```

Seven places were reserved because one extra place is required for the decimal point.

*Each [#] reserves one position. Decimal points,mantissa positive/negative signs, exponents symbols, exponent positive/negative signs, and degree symbols all take up one position each.

Example 6: [LBL] 1 [SHIFT] [ISZ] [MR] 00 [ALPHA] [CAPS] [X] [α-S] [#] [α-S] [,] [Y] [α-S] [#] [ALPHA]
[SHIFT] [PAUSE] [GOTO] 1

To make a count data in M00 displayed like

```
X□, Y□
        □.
```

Note: The underlined section can also be programmed using the AR command as follows.

[ALPHA] [CAPS] [X] [M+/AR] 00 [α-S] [,] [Y] [M+/AR] 00 [ALPHA]

*For both AR and #, the decimal point is not displayed when the value being handled is an integer.

Example 7: [SHIFT] [π] [ALPHA] [α-S] [π] [=] [α-S] [#] [ALPHA] [HLT]

This routine displays the value of π.

```
π = 3.141592654
    3.141592654
```

*If the number of digits of the value being displayed is greater than the number of places reserved, the full value is displayed.
*Up to 99 places can be reserved using #.

Note: If the text display produced using # or AR is longer than 17 characters, the display scrolls to the left until all of the characters are displayed.

Example 8: 1.23 [EXP] 3 [+/-] [ALPHA] [a] [b] [c] [d] [e] [f] [g] [h] [i] [=] [α-S] [#] [ALPHA]

The display that results from the above contains more than 17 characters, and so it scrolls to the left as illustrated below.

```
                ALPHA
abcdefghi = 1.23E-
            1.23-03
```

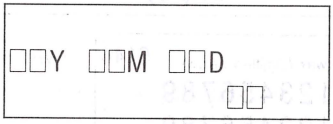
↓

```
(ab) cdefgh = 1.23E-03
             1.23-03
```

③ **Using a semicolon in the first position of text results in the text being appended to the end of previously displayed text, without going to a new line.**

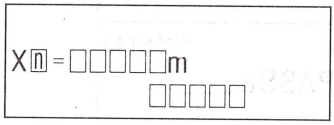
Example 9: ..... [HLT] [Min] 01 [ALPHA] [α-S] [#] [α-S] [#] [CAPS] [Y] [α-S] [EXE SPACE] [ALPHA] [HLT] [Min] 02 [ALPHA] [M−] [α-S] [#] [α-S] [#] [M] [α-S] [EXE SPACE] [ALPHA] [HLT] [Min] 03 [ALPHA] [M−] [α-S] [#] [α-S] [#] [D] [ALPHA] [HLT] .....

This routine reserves two digits for the year, month, and date, and assigns the contents of M01, M02, and M03.



Example 10: ..... [ALPHA] [CAPS] [X] [M+ AR] 00 [=] [ALPHA] [MR] 05 [SHIFT] [RND] [FIX] 2 [ALPHA] [SHIFT] [M−] [α-S] [#] [CAPS] [M] [ALPHA] [HLT] .....

To make a resulting data in M05 rounded off at the two places of decimals and then displayed with n-th index (nth: M00), like



Passwords

- A password is a secret code consisting of any four Alpha mode characters and symbols. Use English characters only to specify the password when using RSSAVE/RSLOAD (see page 85). Assign a password to a program when you do not want anyone to have access to your program, or to prevent a program from being altered or accidentally erased. Program contents cannot be viewed or changed by a user who does not know the password. Calculations can use programs that have passwords, without specifying the password.
- Each program number in this unit can be assigned a password, and 5 steps are required for each password. This means that program numbers P0 through P9 require 6 steps, and P10 through P19 require 7 steps when they are assigned passwords.
- Any valid Alpha mode character can be used in a password. This includes upper and lowercase characters, numbers, symbols and spaces. A password can have four identical characters (such as "JJJJ").

- The following three operations can be performed.

① Passwords can be assigned to programs when the program is created.
② Passwords can be assigned to existing programs.
③ Passwords can be deleted from programs.

Additionally,

① Passwords can be changed during program writing.
② The password input mode can be canceled without deleting the password.
③ Some or all programs with passwords can be deleted.
④ A program number can be changed after a password has been assigned to a program.

■Assigning a Password

- Press [hyp] [Pn] in the WRT mode to enter the password assignment mode, and to automatically enter the Alpha mode ("ALPHA" displayed).
- Enter a 4-character password and the unit returns to the normal WRT mode ("ALPHA" cleared from display).

(1) Password assigned to program when the program is created

Operation	Display	
[MODE] [2]	WRT (Omitted below) 6144 P1-0123456789 P 0123456789	(WRT mode specification)
[hyp] [P0]	hyp ALPHA 6143 P0 PASS____?	(Password assignment mode) (Alpha mode automatically entered)
[A]	ALPHA 6143 P0 PASSa___?	
Example password: "abcd" [B] [C]	ALPHA 6143 P0 PASSabc_?	
[D]	6138 P0 PASSabcd	(Input a 4-character password to automatically exit the Alpha mode. The number of remaining steps is decreased by 6.)
[HLT]	0001 HLT	(Normal write from here)
Normal program write follows [Min] [EXP F]	0002 HLT MinF	

(2) Password assigned to existing program

Operation	Display	
[MODE] [2]	WRT 6028 P1-0123456789 P 01234567__	(Write to P8 and P9 completed)
[hyp] [SHIFT] [P9]	hyp ALPHA 6028 P9 PASS____?	(Password assignment mode)

Assign example password A123 to P9.

[SHIFT] [A] [1]

ALPHA 6028
P9 PASSA1__?

[2] [3]

6023
P9 PASSA123

(Password write completed)

[MODE] [2]

6023
P1-0123456789
P 01234567_*

(Asterisk indicates that a password has been assigned to P9.)

(3) Corrections and deletions during password assignment

- The password can be corrected or deleted as it is input if all four characters have not yet been input.
  Press [C] when up to three characters have been input to clear the characters.
  Press [AC] when up to three characters have been input to delete the password and enter that mode.
  Press [MODE] [1], [MODE] [2], [MODE] [3], or [MODE] [×] when up to three characters have been input to delete the password and enter the respective mode.
- The password cannot be changed or deleted during password assignment if all four characters have been input. For this procedure, see page 66 "How to erase a password".

Note: Any symbol can be used in a password, but only ASCII characters can be handled by the RS-232C interface. Therefore, write the password using English characters only when using RSSAVE/RSLOAD.

■ Number of Steps Required to Specify a Password

Password specification uses the number of steps as shown below.

- Program numbers 0 to 9: 6 steps
  The P*n* specification uses one step, the password specification uses one step, and password input uses four steps, for a total of six steps.
- Program numbers 10 to 19: 7 steps
  The P*n* specification uses two steps, the password specification uses one step, and password input uses four steps, for a total of seven steps.

■ Password Prompt

- In the following cases, the calculator displays the following message to prompt input of the password. This is called the password input mode.)

ALPHA
P1 PASS____?

(1) When a program with a password is specified in the WRT mode, for program check, addition, deletion and correction.
(2) When a program with a password is specified by [GSB] [Pn] for debugging in the RUN mode.
(3) When a program with a password or a password is to be deleted in the PCL mode.
(4) While connected to an optional device, using SAVE, to save a program with a password to cassette tape, RSSAVE to transmit a program with a password via the RS-232C interface, or PRT to print a program with a password.

- The password input mode is exited when the correct password is input and allowing you to proceed with program changes, execution, etc. The unit returns to the password input mode if an incorrect password is input and the password is prompted again.

*If you don't know the password and the unit is in the password input mode:
① Press [AC] to return to the status which existed immediately after the mode change.
② Press [MODE] [1], [MODE] [2], [MODE] [3], or [MODE] [×].
You can proceed with program execution by pressing [EXE] if the unit is in the password input mode in the RUN mode, but you cannot check the program with [BST] when the program is stopped. Programs with passwords cannot be checked during execution.

■How to Erase a Password

•In case of erasing only the "password" of a program:
(1) Enter the PCL mode (MODE 3).
(2) Press Pn which has a password expected to be erased off.
(3) Input a coresponding password.
(4) Press C.
(5) Press MODE 1 (RUN mode), MODE 2 (WRT mode) or MODE × (I/O mode).

•In case of a program with a password to be erased:
(1) Enter the PCL mode (MODE 3).
(2) Press Pn which has a password expected to be erased off.
(3) Input a corresponding password.
(4) Press AC.
(5) Press MODE 1 (RUN mode), MODE 2 (WRT mode) or MODE × (I/O mode).

Note:

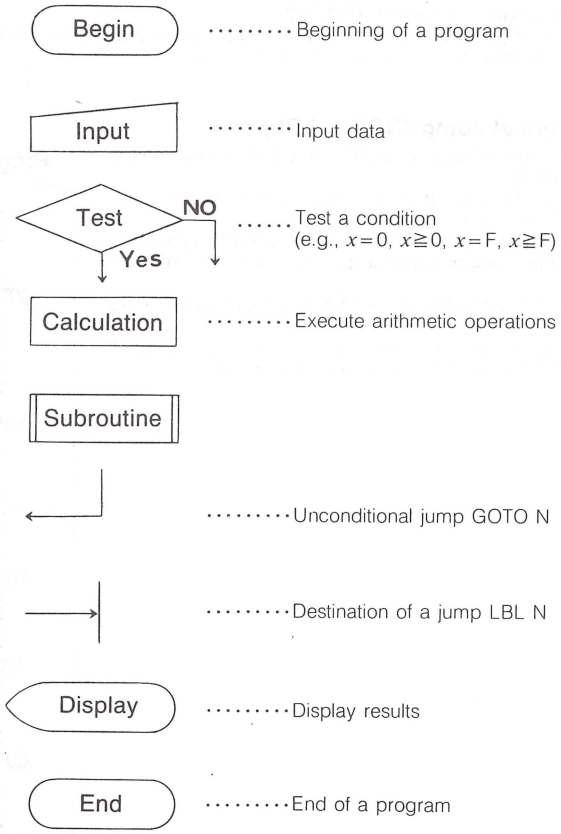
If SHIFT MAC are pressed in the PCL mode, all the programs (P0 through P19) including a program with a password will be cleared.

■How to Change the Password of a Program with a Program Number

(1) Enter the WRT mode (MODE 2) and press the applicable program number key.
(2) Enter the password.
(3) Press C.
(4) Press the program number of a program area that does not contain a program. Note that if the program area for the program number that you press contains anything at all, the program will not be moved to that area.
(5) Enter the RUN mode (MODE 1) or WRT mode (MODE 2).

Flow Chart

- It is suggested that you draw a flow chart which represents a sequence of events occurring when a calculation of interest is executed.
  The flow chart will usually be drawn with symbols as follows:

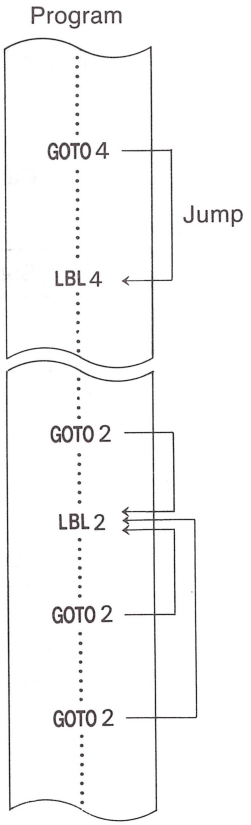


Program Jumping

There are four kinds of jump commands as follows.
(1) Unconditional jump to a designated destination: GOTO, LBL
(2) Conditional jump which reads and skips the next command, depending on the contents of the X-register (display): $x=0$, $x\geqq 0$, $x=$ F, $x\geqq$ F
(3) Conditional jump (count jump) which reads and skips the next command, depending on the contents of the M*n*-register (independent memories): DSZ, ISZ
(4) Subroutine unconditionally jumping to the designated destination and returning back: GSB
These commands can be used independently or in combination.

■Use of Unconditional Jump (GOTO, LBL)

- GOTO N causes control to jump to LBL N of the program unconditionally.
- N is a digit of 0 through 9.
- GOTO N and LBL N can be used anywhere in a program, and 10 pairs of jumps can be used, depending on values of N.
- More than one GOTO N with a same number can be used in a program, while LBL N with a same number is limited to only one to be used in a program.
- In case of no LBL N destined for GOTO N, execution of the program results in error.
- If [GOTO][N] ([0] through [9]) are pressed manually, manual jump is made. If no LBL N is destined in this case, it results in no command.



■Use of Conditional Jump ($x=0$, $x\geqq 0$, $x=F$, $x\geqq F$)

- For the conditional jump, if a comparison between X-register (displayed value) and "numeral 0" or "MF-register value" results in "Yes", the next command can be read in, while if "No", the next command (the whole alphabetical-comments, if so) can be skipped out.
- There are four commands of this type as follows.

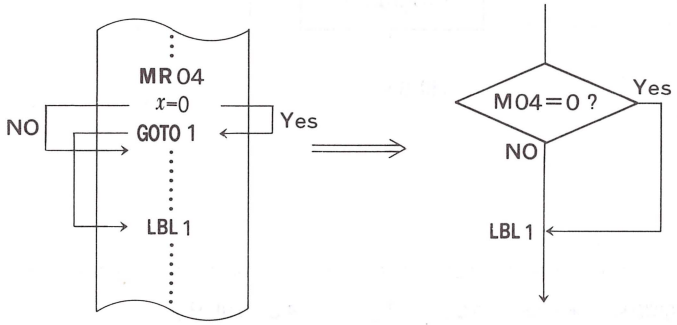
$x=0$: Test is made if the content of the X-register is zero.
$x\geqq 0$: Test is made if the content of the X-register is zero or positive.
$x=F$: Test is made if the contents of the X- and MF-register are equal.
$x\geqq F$: Test is made if the content of the X-register is equal to or greater than that of the MF-register.

•Basic programming

Example 1: If data in M04 is zero, jump to LBL 1:

·····MR 04 , SHIFT $x=0$, GOTO 1 , ····· LBL 1 ·····

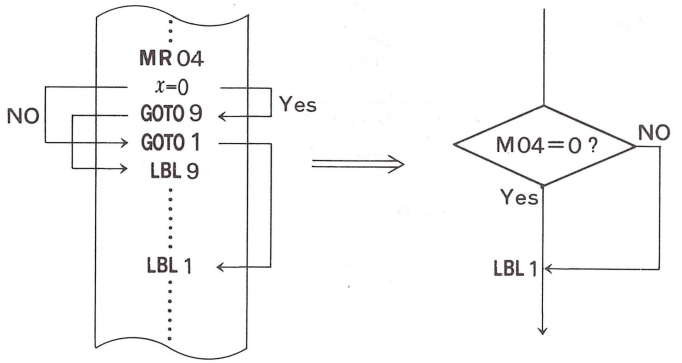
*LBL 1 may be before GOTO 1.



Example 2: If data in M04 is other than zero, jump to LBL 1:

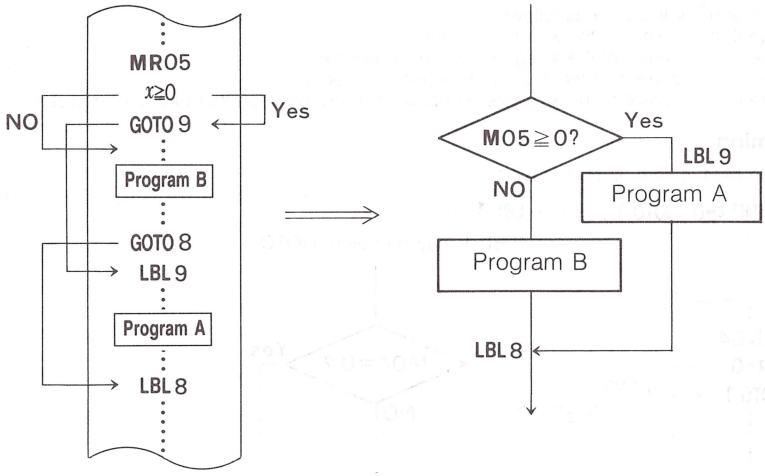
·····MR 04, SHIFT $x=0$, GOTO 9 , GOTO 1 , LBL 9 , ····· LBL 1 , ...

*LBL 1 may be before GOTO 1.



Example 3: If data in M05 is zero or positive, execute program A, while if negative, execute program B.

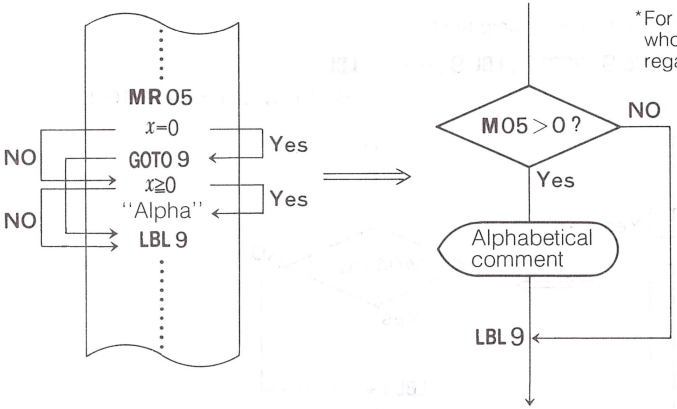
·····MR 05 , SHIFT x≥0 , GOTO 9 , [Program B] GOTO 8 , LBL 9 , [Program A] LBL 8 ,·····



Example 4: If data in M05 is positive, display the alphabetical comment, while if zero or negative, skip it.

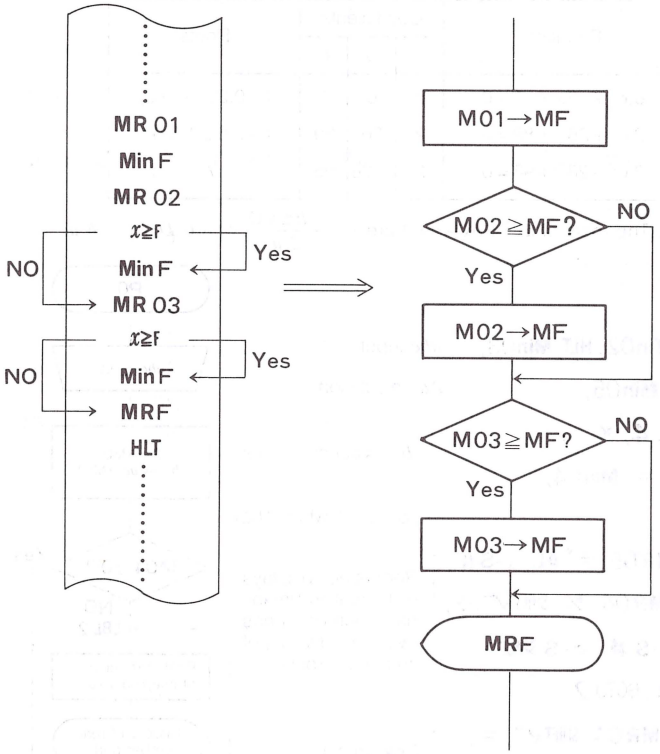
·····MR 05 , SHIFT x=0 , GOTO 9 , SHIFT x≥0 , "AL , alphabetical comment , AL" , LBL 9 ,·····

*For an alphabetical comment,the whole commands ("AL—AL") is regarded as one.



Example 5: To retrieve the largest value registered among M01 through M03.

·····**MR** 01 , **Min** F , **MR** 02 , SHIFT $x \geq F$, **Min** F , **MR** 03 , SHIFT $x \geq F$, **Min** F , **MR** F , **HLT** , ···



(Reference)

In case of retrieving the smallest value registered among M01 through M03:

·····**MR** 01 , +/- , **Min** F , **MR** 02 , +/- , SHIFT $x \geq F$, **Min** F , **MR** 03 , +/- , SHIFT $x \geq F$, **Min** F ,

MR F , +/- , **HLT** , ·····

■Programming Examples, Using the Conditional and Unconditional Jumps

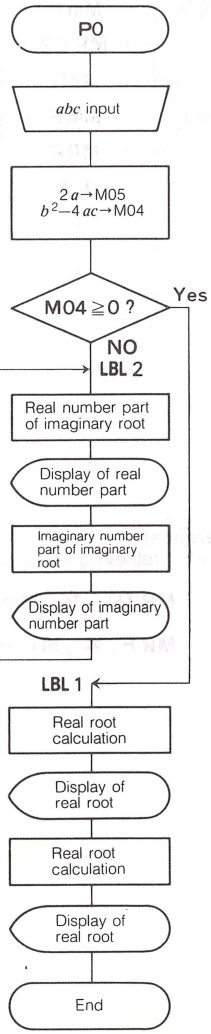
Example: To obtain the roots of quadratic equation in different ways for real and imaginary roots.

No.	Equation	Coefficients			Roots
		a	b	c	
(1)	$8x^2+6x+1=0$	8	6	1	$(-0.25, -0.5)$
(2)	$2x^2+26x+89=0$	2	26	89	$(-6.5 \pm 1.5i)$
(3)	$2x^2-28x+98=0$	2	−28	98	(7)

•Solution: The roots of $ax^2+bx+c=0$ are $x=\dfrac{-b\pm\sqrt{D}}{2a}$ where $D=b^2-4ac$

•Programming (MODE 2)

```
P0 HLT, Min01, HLT, Min02, HLT, Min03,        abc input
  2, ×, MR01, =, Min05,                       2a calculation
  MR02, SHIFT x², −, 4, ×,
  MR01, ×, MR03, =, Min04,                    (b²−4ac) calculation
  SHIFT x≧0, GOTO 1,                          To LBL 1 when D≧0
LBL 2, MR02, ±, ÷, MR05, =, "AL, α-S #,
  AL", 0, SHIFT PAUSE, MR04, ±, SHIFT √, ÷,   Repeating displays
  MR05, =, "AL, α-S #, α-S SPACE,             of the real and imagi-
  i, AL", 0, SHIFT PAUSE, GOTO 2,             nary number parts
                                              (with "i" display) of
                                              imaginary roots
LBL 1, MR02, ±, +, MR04, SHIFT √, =,          Real root 1
  ÷, MR05, =, HLT,
  MR02, ±, −, MR04, SHIFT √, =,               Real root 2
  ÷, MR05, =, HLT,
```



•Execution (MODE 1)

(1)

P0 8 EXE
6 EXE
1 EXE → −0.25
EXE → −0.5

(2)

P0 2 EXE
26 EXE
89 EXE → −6.5 and 1.5i are displayed alternately at interval of about a second.

(3)

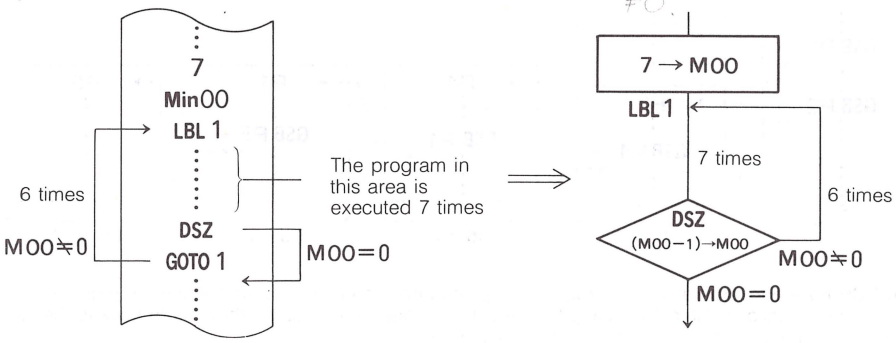
P0 2 EXE
28 ±/− EXE
98 EXE → 7
EXE → 7

■Conditional Jump (Count Jump) (ISZ, DSZ)

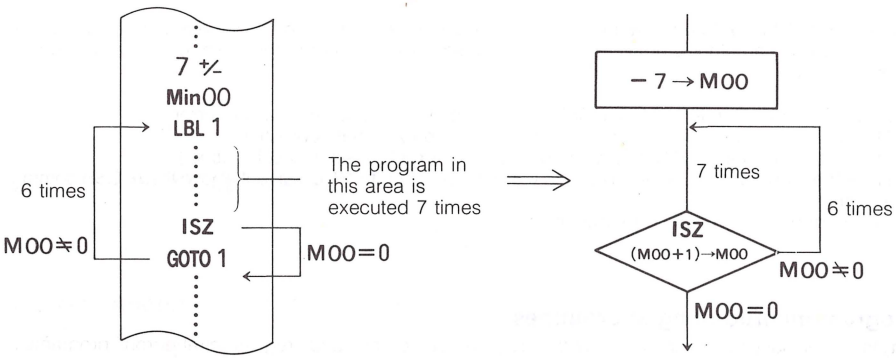
- There are ISZ of positive count and DSZ of negative count in the commands of this type, and both use M00-register (Memory No. 00).
- ISZ adds "+1" to the contlent of the M00-register, while DSZ deducts "−1" from the content of the M00-register. If the content of the M00-register is not zero, the next command is executed; otherwise it (the whole alphabetical comments, if so) is skipped.
- If a same program is repeatingly used (this is called a loop), these commands are very useful.

Examples: To run in a loop 7 times.

With DSZ: ····· 7 , Min 00 , LBL 1 , ····· SHIFT DSZ , GOTO 1 , ·····



With ISZ: ····· 7 , +/− , Min 00 , LBL 1 , ····· SHIFT ISZ , GOTO 1 , ·····

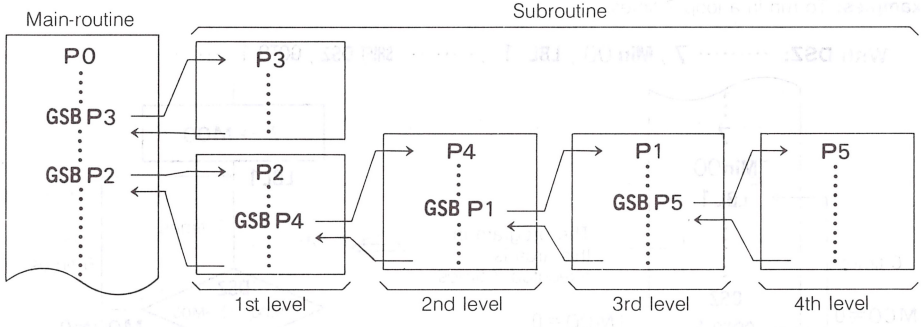


(Reference)

Use of ISZ for program which requires counting saves steps. In this case M00-memory should be used for counting. If it makes 1 M+00, "1" always remains in the display (X-register). However, display remains unchanged with the use of ISZ, and "1" increases only inside the M00.

■Use of Subroutine (GSB)

A program may consist of a main-routine and subroutines. The main-routine composes the central framework in programming. A subroutine is a self-contained part of the main-routine, which can be incorporated as many times as necessary. It can also be incorporated anywhere in the main-routine and even in different ones. In other words, a subroutine performs a certain self-contained part of job which may be requested many times in the main-routine. Use of subroutines makes programming easier and reduces the number of steps.



- Once GSB P*n* are incorporated in a program, they jump into other P*n* programs wherever requiring, from their assigned locations. After completing the execution of destined program, they return back to the steps of original program, which are the next to their departure.
- P*n* is any one of P0 through P19.
- GSB P*n* may be located anywhere in a program.

Note: In case of GSB P*n* to be located in a pair of parentheses, if a closing parenthesis not being a pair with an opening parenthesis or equal sign is assigned on a subroutine, the main-routine is closed with a parenthesis.

- If program P*n* which is referred to by GSB P*n* is undefined, execution results in error.
- GOTO N and LBL N used in a subroutine are effective only in that subroutine.
  (The destination of jump GOTO in a main-routine cannot be located in a subroutine.)
- To call another subroutine out of a subroutine will be possible up to 19 levels, but above them, GSB command will be disregarded.
  (Subroutine depth (=level) is up to 19th level.)

■Program incorporating subroutines

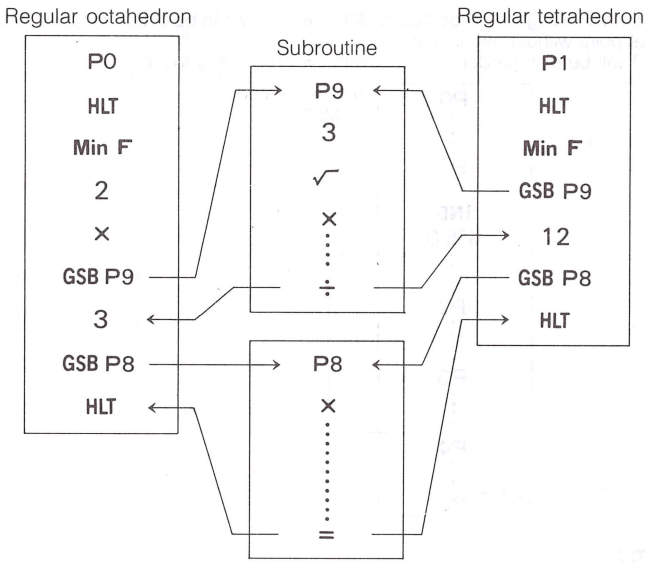
Example: Let's make the common part of the "regular octahedron" and "regular tetrahedron" programs (exampled on pages 41 and 46) into the subroutines.

Regular octahedron: P0 HLT, Min F, 2, ×, GSB SHIFT P9, 3, GSB SHIFT P8, HLT, 8 steps

Regular tetrahedron: P1 HLT, Min F, GSB SHIFT P9, 1, 2, GSB SHIFT P8, HLT, 7 steps

Subroutine: SHIFT P9 3, SHIFT √‾, ×, MR F, SHIFT x^2, =, HLT, 2, SHIFT √‾, ÷, 10 steps

Subroutine: SHIFT P8 ×, MR F, SHIFT x^y, 3, =, 5 steps



The total number of steps of the two main programs are 43 steps (21 + 20 + 2 (P0, P1) = 43), and it is reduced to 34 steps (8 + 7 + 10 + 5 + 4 (P0, P1, SHIFT P9, SHIFT P8) = 34) by using the subroutines. Operation remains unchanged as described on pages 45 and 50.

Use of Indirect Addressing

IND is the command of indirect addressing for designating a register or a destination of jump. Tactful use of this indirect command function greatly contributes to the efficient programming.

■Indirect Addressing of M*n*-register

- Use IND together with register commands (X↔M, Min, MR, M−, M+) to assign the M*n*-register indirectly.
- SHIFT IND, M+*n* (*n*: 2-digit) will address a register indicated by the content of the M*n*-register to execute M+. (The same effect can be produced even by step-by-step operation.)
- If another memory command is assigned in place of above M+, each of them can be executed.

Example:
SHIFT IND X↔M08 executes X↔M05 when 5 is located in M08.

- "*n*" is any one of 00 through 99 and F, 1F through 9F.
- If the M*n*-register contains a number other than 00 through 99, top 2-digit above the decimal point without minus sign can be registered.

Example 1: If −156 is located in M08, SHIFT IND MR08 will execute MR15.
Example 2: If −0.56 is located in M08, SHIFT IND MR08 will execute MR00.

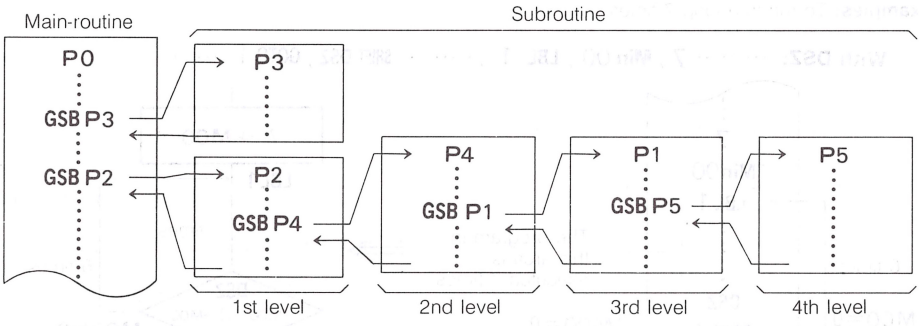
■Indirect Subroutine

- SHIFT IND GSB 0 will call a P*n* program identical with the content of the memory No. 00 (M00-register) as a subroutine.

Example: If 3 is located in M00, SHIFT IND GSB 0 will execute GSB P3.

■Use of Subroutine (GSB)

A program may consist of a main-routine and subroutines. The main-routine composes the central framework in programming. A subroutine is a self-contained part of the main-routine, which can be incorporated as many times as necessary. It can also be incorporated anywhere in the main-routine and even in different ones. In other words, a subroutine performs a certain self-contained part of job which may be requested many times in the main-routine. Use of subroutines makes programming easier and reduces the number of steps.



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- GSB P*n* may be located anywhere in a program.

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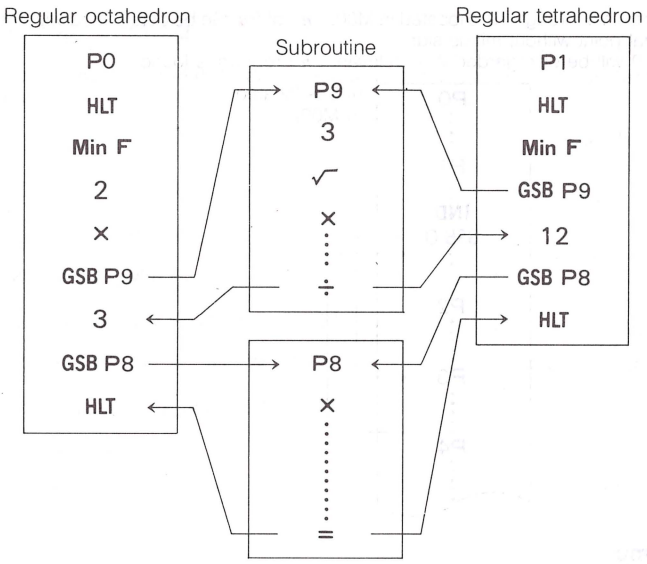
Regular tetrahedron: **P1 HLT , Min F , GSB SHIFT P9 , 1 , 2 , GSB SHIFT P8 , HLT ,** 7 steps

Subroutine: **SHIFT P9 3 , SHIFT √ , × , MR F , SHIFT x^2 , = , HLT , 2 , SHIFT √ , ÷ ,** 10 steps

Subroutine: **SHIFT P8 × , MR F , SHIFT x^y , 3 , = ,** 5 steps



The total number of steps of the two main programs are 43 steps (21 + 20 + 2 (P0, P1) = 43), and it is reduced to 34 steps (8 + 7 + 10 + 5 + 4 (P0, P1, SHIFT P9, SHIFT P8) = 34) by using the subroutines. Operation remains unchanged as described on pages 45 and 50.

Use of Indirect Addressing

IND is the command of indirect addressing for designating a register or a destination of jump. Tactful use of this indirect command function greatly contributes to the efficient programming.

■Indirect Addressing of M*n*-register

- Use IND together with register commands (X↔M, Min, MR, M−, M+) to assign the M*n*-register indirectly.
- SHIFT IND, M + *n* (*n*: 2-digit) will address a register indicated by the content of the M*n*-register to execute M+. (The same effect can be produced even by step-by-step operation.)
- If another memory command is assigned in place of above M+, each of them can be executed.

Example:
SHIFT IND X↔M08 executes X↔M05 when 5 is located in M08.

- "*n*" is any one of 00 through 99 and F, 1F through 9F.
- If the M*n*-register contains a number other than 00 through 99, top 2-digit above the decimal point without minus sign can be registered.

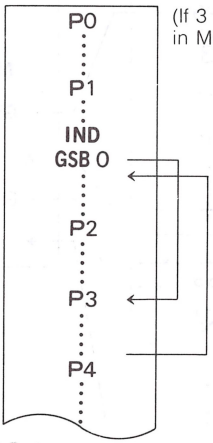
Example 1: If −156 is located in M08, SHIFT IND MR08 will execute MR15.
Example 2: If −0.56 is located in M08, SHIFT IND MR08 will execute MR00.

■Indirect Subroutine

- SHIFT IND GSB 0 will call a P*n* program identical with the content of the memory No. 00 (M00-register) as a subroutine.

Example: If 3 is located in M00, SHIFT IND GSB 0 will execute GSB P3.

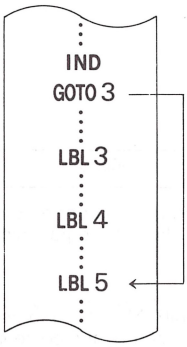
•If a number other than 0 through 19 is located in M00, "*n*" of P*n* can be determined with the top digit number above the decimal point without minus sign.
•SHIFT IND GSB 0 will be disregarded if no relevant P*n* program is found.



(If 3 is located in M00)

■Indirect Jump

•SHIFT IND GOTO *n* is the command of jumping to a LBL *n* identical with the content of the memory No. 0*n* (M0*n*-register).
•"*n*" is any one of 0 through 9 (1-digit number).
Example: If 5 is located in M03, SHIFT IND GOTO 3 will execute GOTO 5 to jump to LBL 5.



(If 5 is located in M03, GOTO 5 will be executed.)

•If a number other than 0 through 9 is located in M*n*, "*n*" of LBL *n* can be determined with the top digit number above the decimal point without minus sign.
Example: If 0.1 is located in M05, SHIFT IND GOTO 5 will assign "0" to "*n*" and jump to LBL 0.
•SHIFT IND GOTO *n* will be disregarded if no relevant LBL *n* is defined.

■Indirect Count Jump

•SHIFT IND SHIFT ISZ or SHIFT IND SHIFT DSZ will cause ISZ or DSZ to operate on the memory register designated with the content of the memory No. 00 (M00-register), According to the resulting content, judgement will be made whether to execute or skip the next command (the whole alphabetical comments, if so).
Example 1: If 5 is located in M00 and 100 in M05, SHIFT IND SHIFT DSZ will decrement 100 in M05 to 99.
Example 2: If 3 is located in M00 and −1 in M03, SHIFT IND SHIFT ISZ will increment −1 M03 to "0", skipping the next command.
•For the M*n*-register to be assigned when a number other than 0 through 99 is located in M00, see "Indirect addressing of M*n*-register".

Elementary Programming

Example 1: To obtain the sum and difference between the largest and the smallest numbers out of various input data: ($x \geqq F$)

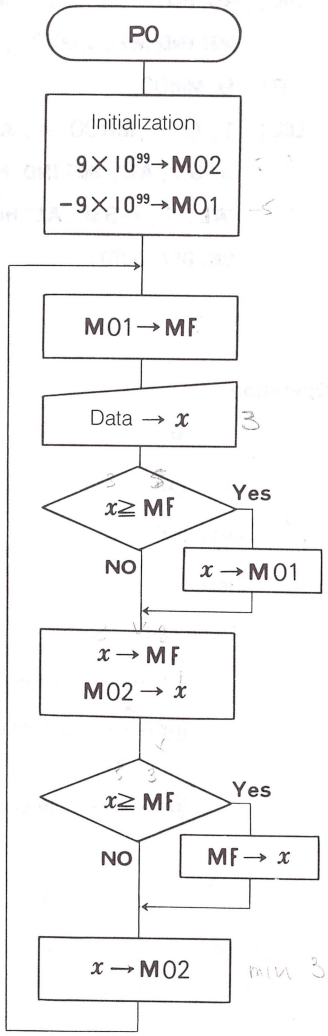
•Program

```
P0   9, EXP, 9, 9, Min 02, +/-, Min 01,
LBL 1, MR 01, Min F, AC, HLT,
       SHIFT x≥F, Min 01, Min F,
       MR 02, SHIFT x≥F, MR F, Min 02, GOTO 1,   20 steps
P1   MR 01, +, MR 02, =, "AL, W, A,
       ;, α-S SPACE, α-S #, AL", HLT,
       MR 01, −, MR 02, =, "AL, S, A,
       ;, α-S SPACE, α-S #, AL", HLT,            24 steps
```

•Operation

- [P0]
- Data [EXE]
- Data [EXE]
- Repeat this.
- At the end
- [P1] ⟶ Sum
- [EXE] ⟶ Difference

•Flow chart



*The flow chart of program P1 is omitted.

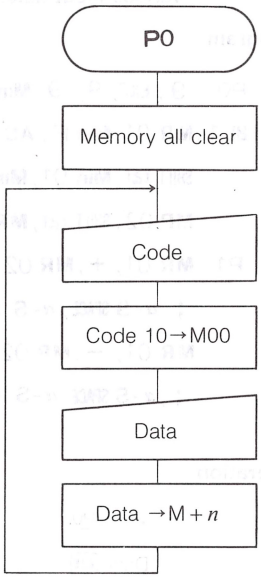
суммировать

Example 2: To input the classification codes (1 to 9) and data, and to summarize data per code: (IND, DSZ)

•Program

```
P0   2ndF MAC,
LBL 1 , AC, HLT, − , 1 , 0 , = , Min00, AC, HLT,
      SHIFT IND, M+00, GOTO 1 ,                    14 steps
P1   9 , Min00,
LBL 1 , 1 , 0 , − , MR00, = , "AL, α-S #,
      α-S :, AL", SHIFT IND, MR00,
      "AL, ; , α-S #, AL", HLT,
      SHIFT DSZ, GOTO 1 ,                          21 steps
```

•Flow chart



•Operation

P0

Code EXE

Data EXE

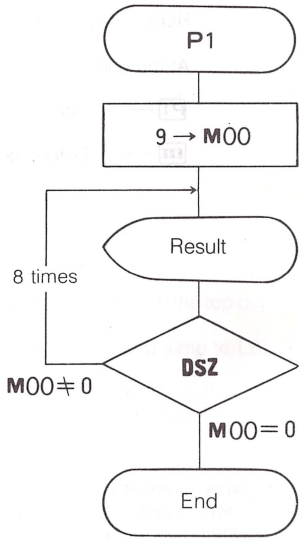
Repeat this.

At the end

P1 ····· Sum of code 1 data

EXE ····· Sum of code 2 data

EXE ····· Sum of code 9 data



Example 3: To input data into nine (1 through 9) M-registers sequentially and display the data.

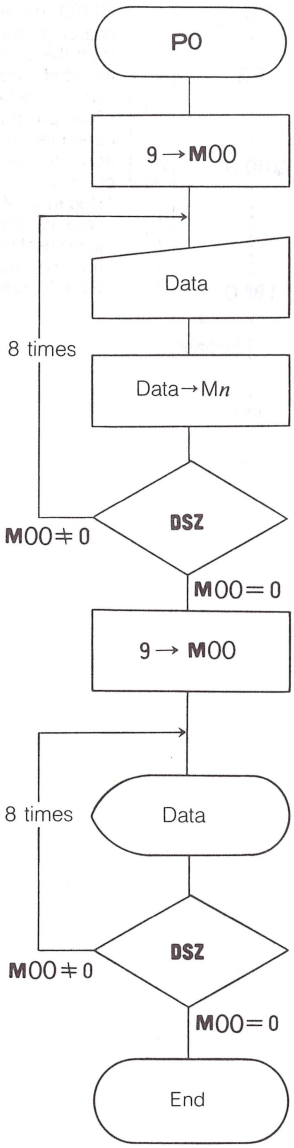
•Program

```
P0  9, Min00,
LBL 1, AC, HLT, SHIFT IND, Min00,
    SHIFT DSZ, GOTO 1,
    9, Min00,
LBL 2, SHIFT IND, MR00, SHIFT PAUSE,
    SHIFT DSZ, GOTO 2,                    17 steps
```

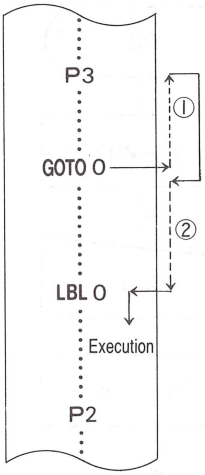
•Operation

	[P0]
Data 1	[EXE]
Data 2	[EXE]
⋮	⋮
Data 9	[EXE] ..... Data will be displayed sequentially at interval of a second.

•Flow chart

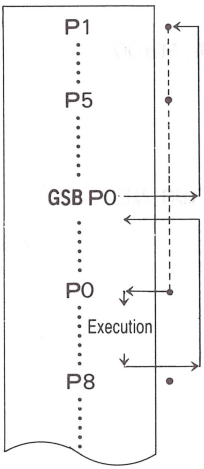


How the Unit Searches for GOTO and GSB Jump Destinations



GOTO causes a backward search for the specified label, from the GOTO command. If the label is not found when the search reaches the beginning of the program, the search is continued in a forward direction, following the GOTO command.

*Because of the above, less time is required when the jump destination is located in the program before the GOTO command.



GSB causes a search for the specified program number, starting from the beginning of the program. Once the object program number is located, that program is executed up to the point that a different program number is encountered. At that point execution returns to the point immediately following the GSB command.

Section 3 Using Peripheral Equipment

A variety of optional peripheral equipment is available to make the following additional functions possible.

1. Storage and recall of program, memories, and display contents

- Store to a cassette tape recorder via the cassette interface of an FA-6 Interface Unit. Connect to the main unit with an SB-7 Cassette Cable.

2. Printing of programs, memories, and display contents

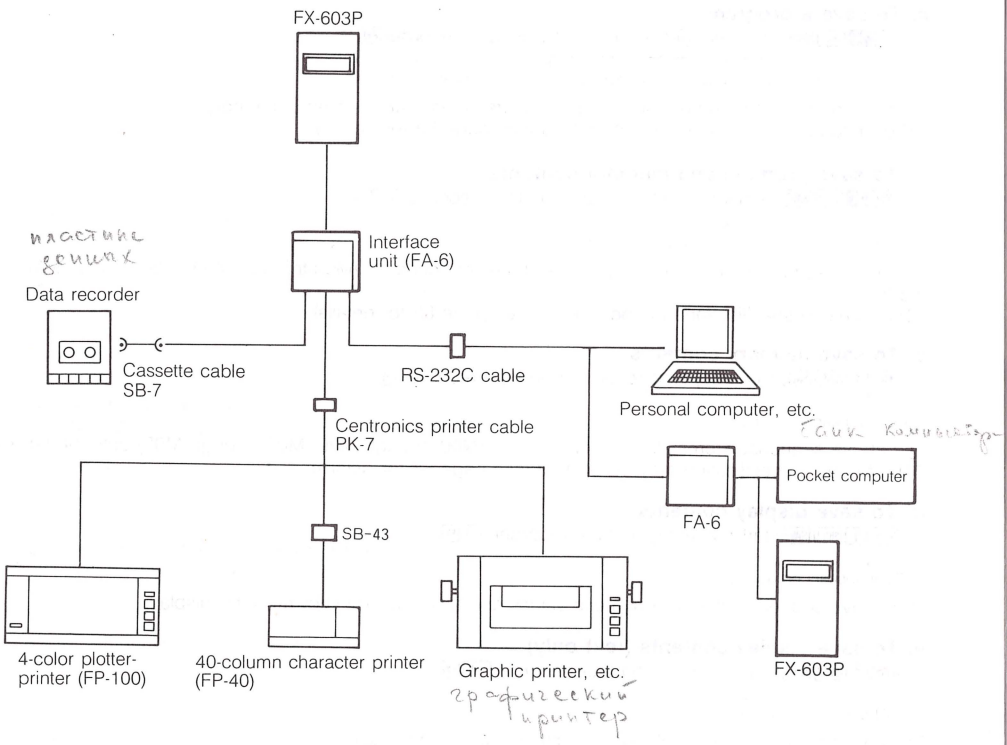
- FP-100 (A4 size paper, 4-color plotter printer)
  Via the printer interface of an FA-6 Interface Unit.
- FP-40 40-column character printer (paper — 112 mm width)
  An SB-43 Interface Unit is required to use the printer interface of an FA-6 Interface Unit.
- Other Centronics standard printers
  Via the printer interface of an FA-6 Interface Unit.

3. Transmission of programs and memory contents to a personal computer or another FX-603P.

See page 85 for details concerning RS-232C parameters and the transfer operation.

- Use the RS-232C interface of an FA-6 Interface Unit to receive data from a personal or pocket computer.

These peripheral devices can be combined to build a powerful computing system as illustrated below.



Saving and Loading Program/Memory Contents and Display Contents (SAVE, LOAD)

Connecting the FX-603P to a standard cassette tape recorder via the FA-6 Interface Unit makes it possible to store program and memory contents to cassette tape for later recall. The following shows the applicable modes for the various procedures.

- Program save/load
- Program + memory contents save/load
- Memory contents save/load
- Display contents save/load
- Display contents (text only) save/load

} I/O mode (MODE ×)

} RUN mode (MODE 1)

■To Save Data to a Cassette Tape

(1) Connect a cassette tape recorder to the FA-6 Interface Unit using a cassette cable (SB-7). See page 92 for instructions on how to correctly make this connection.
(2) Load a cassette tape into the recorder and reset the tape counter to zero. Before loading the tape, be sure that the leader (white or transparent tape) is not exposed at the bottom edge of the cassette. If it is, advance the tape until recording tape is exposed.
(3) Set the record volume level of the tape recorder at or near its maximum setting.
(4) Proceed as described below, according to the type of data you are saving.

a. To save a program

MODE × SHIFT SAVE [filename] Pn start recording on tape recorder EXE

↓ I/O appears on display; ↓ SV appears on display; ↓ Program number specification

Omitting the program number specification sends all programs stored in memory.
*The filename specification may be omitted (see page 88 for details).

b. To save program and memory contents

MODE × SHIFT SAVE [filename] start recording on tape recorder SHIFT EXE

↓ I/O appears on display; ↓ SV appears on display

The above sequence stores all programs and memory contents (M00 through M99, M0F through M9F) onto the tape.
*The filename specification may be omitted (see page 88 for details).

c. To save memory contents

MODE 1 SHIFT SAVE [filename] start recording on tape recorder EXE

↓ RUN appears on display

The above sequence stores all memory contents (M00 through M99, M0F through M9F) onto the tape.
*The filename specification may be omitted (see page 88 for details).

d. To save display contents

MODE 1 SHIFT SAVE start recording on tape recorder SHIFT EXE

↓ RUN appears on display

The above sequence stores all numeric values and text currently shown on the display.

e. To save display contents (text only)

MODE 1 SHIFT SAVE start recording on tape recorder 2ndF EXE

↓ RUN appears on display

The above sequence stores all text currently shown on the display.
*If the tape recorder you are using has a remote control terminal, the EXE operation in the above sequences automatically starts tape movement for recording. If your tape recorder does not have a remote control terminal, you must start and stop tape movement manually.

(5) After the SAVE operation is complete, the display of the unit should be showing the same contents that were displayed before you began the SAVE operation.

Important)
When you save text, the first through 15th characters only are saved. The final character is not saved if 16 characters are currently shown on the display.

- After you save to a cassette tape, it is always advisable to use the VER command to verify that program, memory, or display contents were correctly saved (see page 84 for details).

■To Load Data from a Cassette Tape

(1) Connect a cassette tape recorder to the FA-6 Interface Unit using a cassette cable (SB-7). See page 92 for instructions on how to correctly make this connection.
(2) Load the cassette tape that contains the data you wish to load into the recorder and rewind/fast forward the tape so that the tape counter shows a value that is a little before the location of the data you wish to load.
(3) Set the playback volume level of the tape recorder at or near its maximum setting.
(4) Proceed as described below, according to the type of data you are loading.

a. To load a program

[MODE] [×] [SHIFT] [LOAD] [filename] [Pn] start playback on tape recorder [EXE]

↓ I/O appears on display
↓ LD appears on display
↓ Program number specification

To load all programs, enter [MODE] [3] [2ndF] [MAC] to clear all programs currently stored in the memory of the FX-603P and then proceed as shown above.
*If the filename specification is omitted in the sequence, the first program file found on the tape is loaded (see page 88 for further details).

b. To load program and memory contents

[MODE] [×] [SHIFT] [LOAD] [filename] start playback on tape recorder [SHIFT] [EXE]

↓ I/O appears on display
↓ LD appears on display

The above sequence loads all programs and memory contents (M00 through M99, M0F through M9F).
*If the filename specification is omitted in the sequence, the first applicable file found on the tape is loaded (see page 88 for further details).

c. To load memory contents

[MODE] [1] [SHIFT] [LOAD] [filename] start playback on tape recorder [EXE]

↓ RUN appears on display

The above sequence loads all memory contents (M00 through M99, M0F through M9F).
*If the filename specification is omitted in the sequence, the first memory contents file found on the tape is loaded (see page 88 for further details).

d. To load display contents

[MODE] [1] [SHIFT] [LOAD] start playback on tape recorder [SHIFT] [EXE]

↓ RUN appears on display

The above sequence loads the first numeric value and text file found on the tape.

e. To load display contents (text only)

[MODE] [1] [SHIFT] [LOAD] start playback on tape recorder [2ndF] [EXE]

↓ RUN appears on display

The above sequence loads the first text file found on the tape.
*If your tape recorder does not have a remote control terminal, load the tape into the recorder so that the playback head is located at a position in front of the beginning of the file. Start tape recorder playback, enter the filename or program number that you wish to load, and then press [EXE] to load the file.

Important)
There are slight differences in the methods using by different tape recorders to handle data. To ensure compatibility with as many tape recorder models as possible, the FX-603P can switch phases for data load. If you have a problem with loading data, Enter [MODE] [÷] (R indicator appears in I/O mode) and try again.

Verifying Saved Programs, Memory Contents and Display Contents (VER)

The VER (verify) command lets you check to make sure that the data you saved onto a cassette tape correctly matches the data in memory. To use this command, perform the same procedures as described for program, memory content, and display content load, substituting the operation [2ndF] [VER] (VR indicator appears on display) in place of [SHIFT] [LOAD].

Printing Programs, Memory Contents and Display Contents (PRT)

Connect the FX-603P to the FP-100 Plotter-Printer, the FP-40 Character Printer, or to a standard Centronics printer and you can printout programs, memory contents, and display contents. Note in the following procedures that the modes used for each type of data are the same modes used for the save and load operations.

a. To print a program

[MODE] [X] [2ndF] [PRT] [filename] [Pn] [EXE]

I/O appears on display — PT appears on display — Program number specification

Important)

- During printing of a progam, a new line is inserted whenever any of the following commands is encountered.
  - Following GOTO, GSB
  - Preceding LBL
  - Following HLT, PAUSE
  - Following EXE, SEXE (but not following FEXE)
- Text is printed up to the 15th character only. The final character is not printed if 16 characters are currently shown on the display.
- ASCII codes are used for the printing operation, so non-ASCII characters may be printed differently, as shown in the folowing table. Note that HEX A through F are printed as lower case characters.

ASCII Codes and Substitutions for Output

↔	<>
ENG	SENG
°,,,	DMS
°,,,	SDMS
×	*
÷	/
π	PI
x≧0	x>=0
x≧F	x>=F
$\bar{x}$	MEANX
σn	SDX
σn−1	SDXN
DEL	XDEL
10^x	10^X
e^x	e^X
$\sin^{-1}$	ASN
$\cos^{-1}$	ACS
$\tan^{-1}$	ATN
sinh	HYPSIN
cosh	HYPCOS

tanh	HYPTAN
$\sinh^{-1}$	HYPASN
$\cosh^{-1}$	HYPACS
$\tanh^{-1}$	HYPATN
X^y	X^Y
$X^{1/y}$	X^(1/Y)
R→P	R>P
P→R	P>R
X^2	X^2
√	SQR
Alpha symbol	
×	[MUL]MULTI
÷	[DIV]DIVISION
■	[BLK]BLOCK
μ	[MIC]MICRO
Σ	[SGM]SIGMA
π	[PI]PI
E(EXP)	[EXP]EXPONENT
→	[RTA]RIGHT ARROW
←	[LTA]LEFT ARROW

b. Printing program and memory contents

[MODE] [×] [2ndF] [PRT] [Filename] [SHIFT] [EXE]

↓ "I/O" appears on display

↓ "PT" appears on display

c. Printing memory contents

[MODE] [1] [2ndF] [PRT] [Filename] [EXE]

↓ "RUN" appears on display

d. Printing display contents

[MODE] [1] [2ndF] [PRT] [SHIFT] [EXE]

↓ "RUN" appears on display

Only numeric values are printed when there are no alpha characters. Alpha characters and numeric values are printed when both are displayed.

e. Printing display contents (alpha characters only)

[MODE] [1] [2ndF] [PRT] [2ndF] [EXE]

↓ "RUN" appears on display

Send/Receive of Program and Memory Contents (RSSAVE, RSLOAD)

This unit can use the RS-232C interface of an FA-6 Interface Unit to transfer programs and memory contents between the unit and a personal computer or another FX-603P unit. This command can be used to store the program in the memory of a personal computer for easy editing using an editor.

Warning)

Once a program created on this unit is transferred, it cannot be executed on a personal computer that is running under a different programming language.

The following are the modes that can be used for this operation:

- Program send/receive
- Program + memory contents send/receive
- Memory contents send/receive

} "I/O" mode ([MODE] [×])

"RUN" mode ([MODE] [1])

■Sending Data to a Personal Computer or Another FX-603P

Use an "RSSAVE" command to send programs and memory contents to a personal computer or another FX-603P.

(1) Connect the computer to the FA-6 Interface Unit using an RS-232C cross cable.

(2) Specify the RS-232C parameters. Parameter specifications following ALL RESET are:
Speed: 1200 bps, **Parity:** Even, **Data length:** 8 bits
Stop: 2 bits, **CS:** No check, **DS:** No check, **CD:** No check
Busy: Control
Use the POKE command to change parameters. (See page 89.)

(3) Perform the file receive operation at the personal computer via its RS-232C interface. Proceed as follows (The file receive operation differs according to the operating system or programming language being used. See page 86 for the operation to use with MS-DOS.)

a. Program

[MODE] [×] [SHIFT] [RSSAVE] ([Pn]) [EXE]

↓ "I/O" appears on display

↓ "RS" appears on display

Omitting the program number specification sends all programs stored in memory.

b. Program + memory contents

[MODE] [×] [SHIFT] [RSSAVE] [SHIFT] [EXE]

↓ "I/O" appears on display

↓ "RS" appears on display

All programs and memory contents (M00 to M99, M0F to M9F) are sent.

c. Memory contents

MODE 1 SHIFT RSAVE EXE

↓

"RUN" appears on display

*Memory contents are sent as decimal values in exponential display format.

(4) Once the transmission is complete, the display returns to the status it was in immediately preceding the data transmission.

■Receiving Data from a Personal Computer or Another FX-603P

Use an "RSLOAD" command to receive programs and memory contents from a personal computer or another FX-603P.

(1) Connect the computer to the FA-6 Interface Unit using an RS-232C cross cable.
(2) Specify the RS-232C parameters.
(3) Perform one of the operations described below to enter the receive standby mode.

a. Programs

MODE × SHIFT RSLOAD (Prn) EXE

↓ ↓

"I/O" appears on display "RL" appears on display

Omitting the program number specification receives all programs stored in memory. Prior to this, use the following operation to delete all programs currently stored in the memory of the FX-603P: MODE 3 2ndF MAC.

b. Program + memory contents

MODE × SHIFT RSLOAD SHIFT EXE

↓ ↓

"I/O" appears on display "RS" appears on display

All programs and memory contents (M00 to M99, M0F to M9F) are received. Prior to this, use the following operation to delete all programs currently stored in the memory of the FX-603P: MODE 3 2ndF MAC.

c. Memory contents

MODE 1 SHIFT RSLOAD EXE

↓

"RUN" appears on display

(4) Perform the file send operation at the personal computer to start the receive operation. Once the receipt is complete, the display returns to the status it was in immediately preceding the data receipt.

Note: When performing data communications via the RS-232C interface, passwords assigned to programs can only be made up of ASCII characters.

*The methods used to connect the RS-232C cable and receive files created on personal computers vary depending on the type of personal computer, language and operating system. Familiarize yourself with the personal computer and communications procedures before performing this operation.

Example: Transfer the program (P0) on page 42 from the main unit to a personal computer using the MS-DOS COPY command.

(1) Switch the personal computer power ON.
(2) Boot MS-DOS.
(3) Specify the RS-232C parameters for the personal computer as shown below (if SPEED and EXE parameters are available).

"SPEED. R0 1200 B8 PE S2" ↵

(4) Input the following on the personal computer:

"COPY AUX TEST" ↵

(5) Enter MODE × SHIFT RSAVE P1 EXE to send program P1 and create a TEST file on the personal computer.
(6) Check the contents of the TEST file.

"TYPE TEST" ↵

```
>TYPE TEST
 Program List

 P1

 HLT
 MinF 2 × 3 √ × MRF x² = HLT
 2 √ ÷ 3 × MRF x^y 3 = HLT
 END
```

*"All Program List" is displayed when all programs are sent.
*Note that the RS-232C can only handle passwords created using ASCII characters.

*The following shows the displays that appear during storage, recall, print and RS-232C receipt of programs, memory contents and displays.

•Storage, recall, print and receipt of programs

```
PA  PF  ABC-3
```

Program 0
(File name: ABC – 3)

If specify the program number, "P*n*" appears on display.

•Storage, recall, print and receipt of programs + memory contents

```
PA  AF  123.
```

(File name: 123)

If specify the program number, "P*n*" appears on display.

•Storage, recall, print and receipt of memory contents and displays

```
    DF  123.
```

(File name: 123)

About Filenames

Programs and other memory contents can be stored under filenames. A filename can consist of three numeric characters or six alphabetic characters. The filename can be omitted when saving a file, which results in the file being saved under a filename that consists of blanks only.

Example: Save a file in program area P0, under the filename ABC–3.

MODE × SHIFT SAVE ALPHA CAPS P0(A) P1(B) P2(C) (–) 3 ALPHA P0 Start recording of (cassette) recorder EXE

*If you omit the filename when recalling the file, the first file of the same type (program or memory) found on the tape that has the same attributes is recalled as the default.

PEEK/POKE Commands

This unit has a total of 8 kbytes (8,192 steps) of memory capacity, including 6 kbytes (6,144 steps) for the programming area and 880 bytes for the independent memory areas. Addresses are allotted within these memories in byte sequence. You can read data from a specific address using the PEEK command, and write data to an address with the POKE command.

■PEEK

Use this command to read the memory contents at a specific address. There are three ways to specify an address:

1. **PEEK 2345** (directly reads value at specified address)
2. **PEEK MR15** (reads value at address specified by value of independent memory "MR15")
3. **PEEK IND MR10** (reads value at address in indirectly specified memory; see indirect specification on page 75)

*The address unit is one byte, so the memory contents are also read in one byte units.

■POKE

Use this command to write data to a specific address. The address should be specified within the range of 0000 to 8191, while data can be written as decimal integers within the range of 0 to 255 ($0 \leqq n < 256$).

Example: 123 POKE 2345 (writes data "123" at address "2345")

*The address unit is one byte, so the write data is also one byte.

*Illegal address or input data specifications are converted to a legal form automatically. Values in the BASE-N mode are converted to decimal values and processed.

Example: BB 8 (16) POKE 23456

→ Uses first four digits and specifies address "2345".

→ "BB8" equals decimal number 3000. Since the range is 0 through 255, this is converted to 30.

Notes)

- **Addresses 8192 to 9998 are pseudo addresses and data cannot be read from or written to these addresses. Never specify addresses 9980 to 9998 because doing so will destroy memory contents.**
- **Be very careful when using POKE to change memory contents. Certain changes in memory can cause uncontrollable execution.**

■PEEK/POKE Command Expansion Function

This unit can be expanded with the PEEK/POKE command to include the following functions.

1. Changing of storage/recall speed and phase of cassette tape recorder
2. RS-232C parameter specification
3. Code output for Centronics printer

•Changing of storage/recall speed and phase of cassette tape recorder

This unit can change the read speed and phase of the tape recorder used for storage and recall of programs. Select the binary mode and specify memory address "0891" to read the data contents with a PEEK command. The data appears as follows (when not MT Reverse):

(Address "0891") 0 0 0 0 0 0 0 0 0 0 0 0 0 I I 0

→ Read speed

→ Unused

→ Phase

→ Unused

Use the POKE statement to change the data as follows:
① Store/recall speed (tape transfer speed)
110: 300 BPS
100: 1200 BPS
② Phase (phase when reading from tape)
0: Positive
1: Reverse

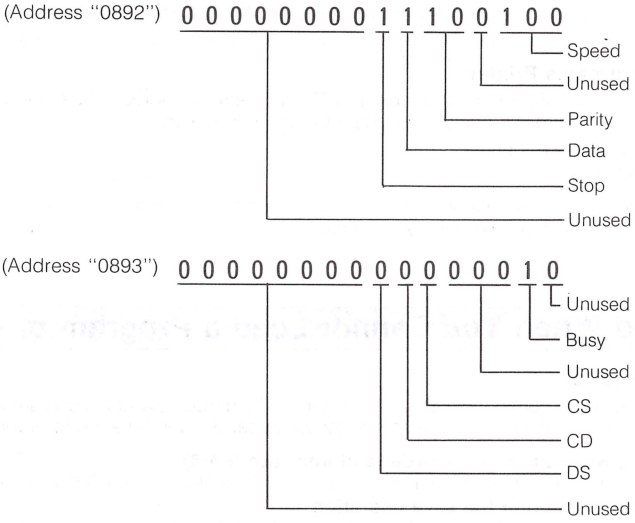
Note: Data cannot be recalled if the speeds do not match. See Important on page 83 for details about phases.

Example: Change to 1200 BPS, positive phase.
[MODE] [−] [SHIFT] [BIN] 00000100 [2ndF] [POKE] 0891

*Following ALL RESET, the speed is 300 BPS, and the phase is positive.
*Store/recall speed and phase remain in effect until they are altered or ALL RESET is performed.

•Specifying RS-232C Parameters

This unit allows you to specify the RS-232C parameters. Use the PEEK command to read the data at memory addresses 0892 and 0893.



Parameters are specified by changing the contents of addresses 0982 and 0983.
① Speed (data transfer speed)
010: 4800 BPS
011: 2400 BPS
100: 1200 BPS
101: 600 BPS
110: 300 BPS
111: 150 BPS
② Parity (checks whether or not data is correctly sent)
00 and 01: No parity bit
10: Even
11: Odd
③ Data (determines number of bits needed per character)
0: JIS 7 bits
1: JIS 8 bits (JIS = Japan Industrial Standard)
④ Stop (indicates the end of a character)
0: 1 bit
1: 2 bits

⑤ Busy (Busy, (XON/XOFF), temporary halt of data transfer)
0: Don't use
1: Use (halts data transfer when transfer speed is too fast and resumes data transfer)
⑥ CS (Clear to send (CTS))
0: Don't use
1: Use (data transfer waits until CS goes from OFF to ON)
⑦ CD (Carry detect)
1: Don't use
0: Use (data receive when CD is OFF causes "OP Error")
⑧ DS (Data set ready (DSR))
0: Don't use
1: Use (data receive when DS is OFF causes "OP Error")
For send, waits until DS goes to ON.

Example: Change speed from 1200 BPS to 2400 BPS following ALL RESET.

[MODE] [−] [SHIFT] [BIN] 11100011 [2ndF] [POKE] 0892

*Following ALL RESET:
Speed: 1200BPS, **Parity:** EVEN, **Data:** 8 bits
Stop: 2 bits, **Busy:** XON, **CS:** OFF, **CD:**OFF, **DS:** OFF
*RS-232C parameters remain in effect until they are changed or ALL RESET is performed.

•Output Code for Centronics Printer

Anytime you write a value within the range of 0 through 255 into memory address 9999, the corresponding ASCII code is output to the Centronics printer connected to the FA-6 Interface Unit.

Example: Print "}" on a Centronics printer.

[MODE] [−] [HEX] 7D [2ndF] [POKE] 9999

*After output of the printer code, subsequent operation depends on the printer specifications. Use the above procedure only after familiarizing yourself with your printer.

What to Do When You Cannot Load a Program or Data

■From a cassette tape

Following execution of the LOAD command, if the unit stays in the load mode (symbols only shown on the display) and the tape continues to advance, check for the following causes and take the appropriate actions.

(1) Poor connection between the tape recorder and interface (FA-6)
Connect the units securely and make sure that the RS-232C/MT switch of the FA-6 is set to MT.

(2) Record level set too low during the save operation
After saving data to a tape, be sure to use the VER command to varify that the save operation was completed successfully. When using a battery powered tape recorder, insufficient battery power may make it impossible to save data at a proper level.

(3) Playback level too low
Adjust the playback volume to find the best level. If you still have the same problem after adjusting the playback level, try using a different tape recorder with greater output capacity.

(4) Diferent phase used for recording and playback
This problem occurs if different tape recorders are used for recording and playback and one of the tape recorders is equipped with a phase switch. Use a tape recorder with a phase switch when loading (playing back) the program and make sure that the switch is in the same setting as that used when the program was saved (recorded).

(5) Different data transfer speed used for recording and playback
This problem is caused by trying to use a speed of 1200 BPS to load a program saved at 300 BPS,or vice versa. Make sure that you use the same speed as that used when saving the program.

(6) Tape leader not skipped during save operation
The tape leader cannot record anything, so loading is impossible. To avoid this problem, use the VER command to verify that the save operation was completed successfully.

•If an "OP Error" occurs following execution of the LOAD command, check for the following causes and take the appropriate actions.

(1) **Programs or data impossible to read because tape recorder heads are dirty**
Clean off the tape recorder heads and pinch roller.

(2) **Playback level too high**
Adjust the playback volume to find the best level. A level that is too low makes the signal susceptible to noise,while a level that is too high can be distorted.

(3) **Error generated because tape is cracked, bent, stretched, or damaged by exposure to magnetism**
Be careful when handling and storing cassette tapes. Avoid storing tapes in areas exposed to magnetism (near speakers, televisions, radios, monitors), high temperatures (which can lower the tape's ability to retain magnetism), or large amounts of dust.

(4) **Error generated by playback noise on tape**
Try saving data connecting only the red plug of the cassette cable (SB-7), and connecting only the white plug of the cable for loading data. Use a different tape recorder or cassette tape.

■Via the RS-232C interface

Following execution of the RSLOAD command, if the unit stays in the load mode (symbols only shown on the display) and the tape continues to advance, or if an "OP Error" occurs following execution of the LOAD command, check for the following causes and take the appropriate actions.

(1) **RSLOAD command being used differs from type of RSSAVE command used to save data**
Check the type of data you are trying to receive and perform the proper operation.

(2) **Mismatch of RS-232C parameters**
Make sure that the parameters of the sending and receiving units match.

(3) **Incorrect format in program or memory contents being received**
Confirm that format of program or memory contents being received is correct.

(4) **Parity error or framing error**
Check the RS-232C parameters and try again.

Compatibility with FX-602P Programs

Programs created on the FX-602P can be run on this unit without modification. Data recorded on a cassette tape with an FX-602P can be read with a "LOAD" command. "INV EXE" used by the FX-602P is converted to "SEXE" at that time. Program compatibility is determined in accordance with the following.

•FX-502P → FX-602P → FX-603P unit (compatible)
•FX-603P → FX-602P or FX-502P (not compatible)
•FX-502P → FX-603P (not compatible)
*Direct transfer from FX-502P cannot be performed.

Notes:

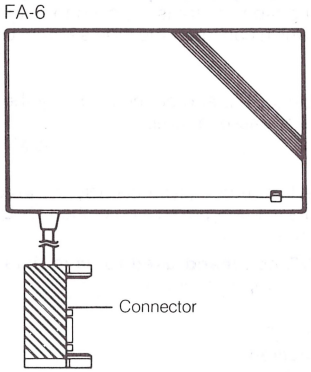
•The I/O unit in the FX-602P uses the FA-2, so a printer for an FX-602P cannot be used.
•This unit can perform any program the FX-602P can perform, with the exception of "music".
•When reading all programs, enter MODE 3 2ndF MAC. Perform this procedure after first deleting all programs in the FX-603P.
•The data transfer speed of the FX-602P is 300 BPS, so be sure to set this speed when loading data that has been saved using the FX-602P.

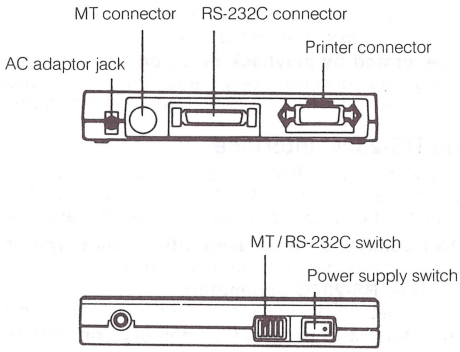
FA-6 Interface Unit

■Features

The FA-6 Interface Unit features a cassette interface, RS-232C interface, Centronics interface, and Centronics printer interface.

■ The power supply switch and a switch for changing between the RS-232C interface and the cassette interface are on the front of the interface unit.
An RS-232C interface, printer interface, and cassette interface terminal, as well as an AC connector are located on the back of the unit.
A battery holder is also included on the back of the unit. To replace the batteries, remove the cover and take out the dead batteries. Insert the new batteries, matching the ⊕ and ⊖ marks on the batteries with those in the battery holder. See the FA-6 Interface Unit User's Manual for details.





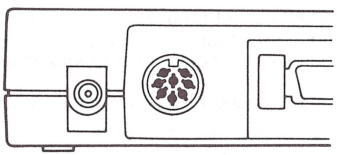
■ Connections

When installing the FX-603P onto the FA-6 Interface Unit, be sure that the power supply switches for both units are OFF. Once the FX-603P is installed on the FA-6, switch on the FA-6 Interface Unit first, and then the FX-603P.

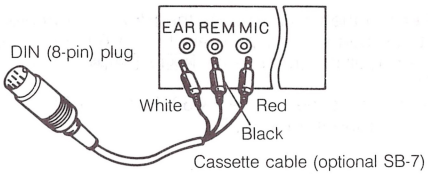
■ Cassette Interface

The cassette interface is used to record data and programs to, and read data and programs from cassette tape. Use an optional SB-7 Cable to connect the FA-6 with a cassette tape recorder. Connect the red cable to the "MIC" or "LINE IN" jack, and the white cable to the "EAR" or "LINE OUT" jack of the tape recorder. Connect the black cable to the "REM" jack, if the tape recorder is equipped with a remote control function. Set the MT/RS-232C switch to MT when using the cassette interface.

FA-6



Cassette tape recorder jacks



EAR: Output (earphone) . . . white plug
REM: Remote control . . . black plug
MIC: Input (microphone) . . . red plug

Note: If the tape recorder being used does not have a remote control function, leave the black plug disconnected.

When recording programs and data to a cassette, first set the cassette tape recorder to record and then execute a "SAVE" or other command on the FX-603P. When reading from cassette tape, first execute a "LOAD" or other command on the FX-603P and then set the cassette tape recorder to playback.

■Printer Interface (Centronics)

The printer interface makes it possible to connect a Centronics printer to the FA-6.
*Use an optional PK-7 Printer Cable to connect a printer to the FA-6 Interface Unit.

■RS-232C Interface

The RS-232C Interface is used for data communications. Move the MT/RS-232C switch to RS-232C when using the RS-232C interface.

Specifications

Communications method: Start-stop synchronous (asynchronous) full duplex mode only
Transfer speed: 150, 300, 600, 1200, 2400, 4800 BPS
Parity bit: Odd, even, no parity
Data bit: 7 or 8 bits
Stop bit: 1 or 2 bits
CTS signal control: Control, ignore
DSR signal control: Control, ignore
CD signal control: Control, ignore
Busy control: XON/XOFF control, no control

Note: Use a cross cable when connecting the interface unit to another FX-603P via the RS-232C or the RS-232C of a personal computer.

FP-100 Plotter Printer

The optional FP-100 4-color plotter printer can be used for multi-color printing of programs and calculation results.

■Features

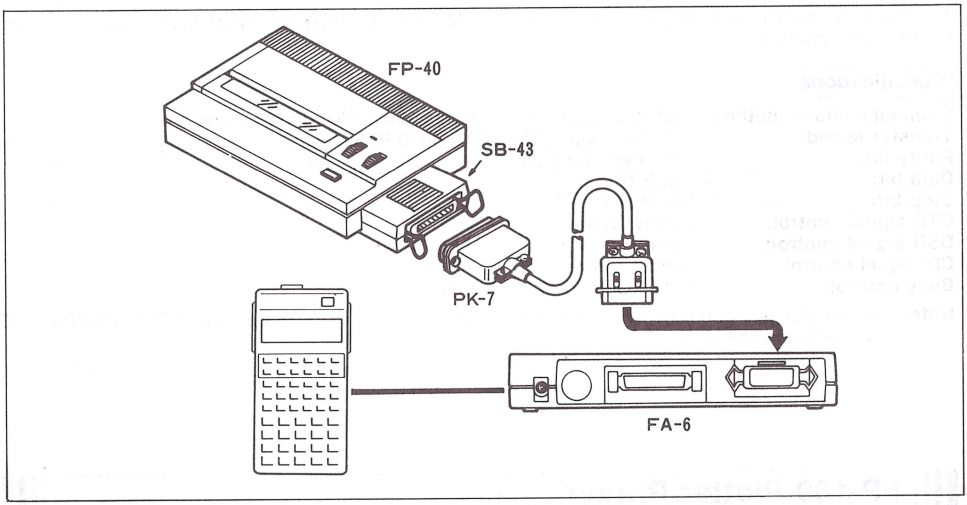
- 4-color print (black, red, blue, green)
- Character styles: italics
- Print resolution: (0.2 mm/step)
- Paper: Width: 100 ~ 216 mm
  Thickness: 0.07 ~ 0.3 mm
- Roll paper: Outside diameter: 40 mm max.
  Inside diameter: 12 mm min.
- Character size: (256 varieties from 1.0 mm × 1.2 mm (S0,0) to 16.0 mm × 19.2 mm (S15,15))

■Connection

Connect the printer and the FX-603P through an FA-6 Interface Unit using an optional PK-7 Printer Cable.
*Use only the Casio PK-7 Printer Cable.

FP-40 Character Printer

The FX-603P can be connected to an FP-40 Character Printer. If you have an FA-6 Interface Unit, connect as shown in the diagram.



*Connect the FP-40 Character Printer and FX-603P via the FA-6 Interface Unit using an optional SB-43 Interface Pack and PK-7 Printer Cable.

■Function Input Ranges and Precision

Function	Input Range	Internal Calculations	Accuracy	Remarks
sin cos tan	DEG $\|x\| < 9\times10^{9}$° RAD $\|x\| < 5\times10^{7}\pi$rad GRA $\|x\| < 1\times10^{10}$grad	12 digits	As a rule, accuracy is ±1 at the 10th digit.	However, for tan x $\|x\| \neq 90(2n+1)$: DEG $\|x\| \neq \pi/2(2n+1)$: RAD $\|x\| \neq 100(2n+1)$: GRA
$\sin^{-1}$ $\cos^{-1}$	$\|x\| \leqq 1$	,,	,,	
$\tan^{-1}$	$\|x\| < 1\times10^{100}$			
sinh cosh	$\|x\| \leqq 230.2585092$	,,	,,	Note: Errors generated for sinh and tanh when $x=0$. Error accumulates in this vicinity affecting precision.
tanh	$\|x\| < 1\times10^{100}$			
$\sinh^{-1}$	$\|x\| < 5\times10^{99}$	,,	,,	
$\cosh^{-1}$	$1 \leqq x < 5\times10^{99}$			
$\tanh^{-1}$	$\|x\| < 1$			
log ln	$1\times10^{-99} \leqq x < 10^{100}$	,,	,,	
10^{x}	$-1\times10^{100} < x < 100$	,,	,,	
e^{x}	$-1\times10^{100} < x \leqq 230.2585092$			
$\sqrt{\ }$	$0 \leqq x < 1\times10^{100}$			
x^{2}	$\|x\| < 1\times10^{50}$			
$1/x$	$\|x\| < 1\times10^{100}$, $x \neq 0$	,,	,,	
$x!$	$0 \leqq x \leqq 69$ (x is an integer)	,,	,,	
R→P	$x^{2}+y^{2} < 1\times10^{100}$	,,	,,	
P→R	$0 \leqq r < 1\times10^{100}$ DEG $\|\theta\| < 9\times10^{9}$° RAD $\|\theta\| < 5\times10^{7}\pi$ rad GRA $\|\theta\| < 1\times10^{10}$ grad			However for tan x $\|x\| \neq 90$ $(2n+1)$: DEG $\|x\| \neq \pi/2$ $(2n+1)$: RAD $\|x\| \neq 100$ $(2n+1)$: GRA
° ′ ″	$\|a\|$, b, $c < 1+10^{100}$ $0 \leqq$ b, c	,,	,,	
°′″	$\|x\| < 1\times10^{100}$ Sexagesimal display $\|x\| \leqq 277777.7777$			

Function	Input Range	Internal Calculations	Accuracy	Remarks
x^y	$x>0$: $-1\times10^{100}<y\log x<100$ $x=0$: $y>0$ $x<0$: $y=n$, $1/(2n+1)$ (n: integer) However $-1\times100^{100}<1/y\log\|x\|<100$	12 digits	As a rule, accuracy is ±1 of the 10th digit.	
$x^{1/y}$	$x>0$: $y\neq0$ $-1\times100^{100}<1/y\log x<100$ $x=0$: $y>0$ $x<0$: $y=2n+1$, $1/n$ ($n\neq0$, n: integer) However, $-1\times10^{100}<1/y\log\|x\|$ <100	,,	,,	
$a^b/_c$	Total of integer, numerator and denominator must be within 10 digits (includes division marks).	,,	,,	
SD	$\|x\|<1\times10^{50}$ $\|n\|<1\times10^{100}$ σn : $n\neq0$ σn-1 : $n\neq0$, 1	,,	,,	
BASE-N	Range for values after conversion Dcc : $-2147483648\leqq x$ $\leqq2147483647$ Bin : 10000000 00000000 $\leqq x\leqq$ 11111111 11111111 (Negative) $0\leqq x\leqq$ 01111111 11111111 (0, positive) Oct : $20000000000\leqq x$ $\leqq$ 37777777777 (negative) $0\leqq x\leqq$ 17777777777 (0, positive) Hex : $80000000\leqq x$ $\leqq$ FFFFFFFF (negative) $0\leqq x\leqq$ 7FFFFFFF (0, positive)	32 bits (BIN: 16 bits)	Integer range	

*Performing continuous calculations such as x^y, $x^{1/y}$, and $x!$ accumulates error and affects precision.

Specifications

Model: FX-603P

Calculator

Basic calculation functions:
Negative numbers; exponents; addition, subtraction, multiplication, division, including parenthetical operations (with priority sequence judgement function); arithmetic constant calculations

Built-in functions:
Trigonometric, inverse trigonometric functions (units of angular measurement: degrees, radians, grads); hyperbolic, inverse hyperbolic functions; logarithmic, exponential functions; reciprocals; factorials; square root; squares; powers; roots; decimal-sexagesimal conversions; binary-octal-hexadecimal calculations; coordinate conversions; absolute values; integer exclusion; decimal exclusion; percentages, premiums, discounts, ratios, rate of change; random numbers; π

Statistical calculation functions:
Standard deviation (two types); mean; sum; sum of squares; number of data items

Memories: 110 independent memories in 5 key modes (fixed)

Calculation range: $\pm 1 \times 10^{-99}$ to $\pm 9.999999999 \times 10^{99}$ and 0. 12-digit mantissas for internal operations.

Decimal point system: Full floating decimal point system (with engineering floating decimal display)

Rounding: According to the specified number of significant digits or the number of specified decimal places.

Programs

Number of steps: 6,144 maximum

Jump function: Unconditional jump (GOTO), 10 maximum
Conditional jump ($x=0$, $x \geqq 0$, $x=F$, $x \geqq F$)
Count jump (ISZ, DSZ)
19 subroutines (GSB), depth (19 levels)

Number of stored programs: 20 maximum (P0 to P19)

Check/edit function: Program checking, debugging, deletion, addition, etc.

Indirect specification function: Indirect memory address, indirect jump, indirect subroutine, etc.

Other functions: Manual jump (GOTO), program PAUSE, command and step number display during write/check, program passwords, connection with FA-6 Interface Unit (option)

General

Number of display digits and formats:
10-digit mantissas (including minus sign), 2-digit exponents, two-tier liquid crystal display, hexadecimal display, sexagesimal display, condition displays for ([S], [F], [MODE], hyp, K, HLT, RUN, WRT, PCL, I/O, BASE-N, DEG, RAD, GRA, [d], [h], [b], [o], ALPHA, and CAPS)

Character display function: 32-character program command display, 16-character comment display

Characters: Upper and lower case alphabetic characters, numbers, symbols and special characters (total of 86 characters)

Error check function: Checks for values exceeding 10^{100}, illogical calculations and jumps; error messages displayed

Power supply: 2 lithium batteries (CR2032) for the mainframe
1 lithium battery (CR2032) for memory backup

Power consumption: 0.03W (main unit only)

Battery life: Approximately 160 hours (continuous program use)
Approximately 370 hours ("0" displayed continuously)

Auto power off: Power is automatically switched off approximately 6 minutes after the last operation.

Ambient temperature range: 0°C ~ 40°C (32°F ~ 104°F)

Dimensions: 12.9 mm (H) × 78 mm (W) × 155.5 mm (D) ($^{1}/_{2}$" (H) × 3" (W) × 6$^{1}/_{8}$" (D))

Weight: 136 g (4.8 oz) including batteries